No. 16-1004

UNITED STATES COURT OF APPEALS
FOR THE FEDERAL CIRCUIT

TDE PETROLEUM DATA SOLUTIONS, INC.,
Plaintiff – Appellant,

vs.

AKM ENTERPRISE, INC. DBA MOBLIZE, INC.,
Defendant – Appellee.

Appeal from a Judgment of the
United States District Court for the Southern District of Texas, Houston Division
District Court Case No. 4:15-CV-01821
Honorable Gray Miller, Presiding District Judge

APPELLANT TDE PETROLEUM DATA SOLUTIONS, INC.'S PRINCIPAL BRIEF

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Certificate of Interest

Counsel for Plaintiff-Appellant hereby certifies the following:

1. The full name of every party presented by me is:

TDE Petroleum Data Solutions, Inc.

2. The name of the real party in interest (if the party named in the caption is not the real party in interest) represented by me is:

The real parties in interest are named in the caption.

3. All parent corporations and any publicly held companies that own 10 percent or more of the stock of the party or amicus curiae represented by me are:

TDE Thonhauser Data Engineering GmbH owns more than 10% of TDE.

4. The name of all law firms and the partners or associates that appeared for the party or amicus now represented by me in the trial court or agency or are expected to appear in this court (and who have not or will not enter an appearance in this case) are:

Whittaker Law Firm: Malcolm Edwin Whittaker

Pillsbury Winthrop Shaw Pittman LLP: Callie McCarthy Bjurstrom, Matthew Robert Stephens, Nicole Sara Cunningham, Steven Arthur Moore

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Statement of Related Cases

Pursuant to Federal Circuit Rule 47.5, Plaintiff-Appellant provides as follows:

(a) There have been no previous appeals in this case; and

(b) Plaintiff-Appellant is not aware of any other cases that will directly affect or be directly affected by the Court's decision in this case.

Jurisdictional Statement

This appeal is from the United States District Court for the Southern District of Texas, Houston Division, Case No. 4:15-CV-01821, Judge Gray H. Miller, presiding. The district court had jurisdiction pursuant to 28 U.S.C. §§ 1331 and 1338(a), and entered final judgment on September 11, 2015. Plaintiff-Appellant filed a timely notice of appeal on September 22, 2015. This Court has jurisdiction under 28 U.S.C. §1295(a)(1).

Statement of Issues on Appeal

1. Whether United States Patent No. 6,892,812 is directed to a subject matter eligible for patent protection under Section 101 of the Patent Act and the Supreme Court's decision in *Alice Corp. v. CLS Bank, Int'l*.

2. Whether the District Court erred in finding that the claims of United States Patent No. 6,892,812 are not patent-eligible and in granting Defendant's motion to dismiss on that basis.

<u>Statement of the Case</u>

I. Preliminary Statement

This is a patent infringement case involving TDE's United States Patent No. 6,892,812 (the "'812 patent") titled "Automated Method and System for Determining the State of Well Operations and Performing Process Evaluation." The '812 Patent is directed to a method for providing automated determination of well states that utilizes data collected from available mechanical and hydraulic sources, performs quality control on the data and formats it for decision-making on rig activity in real or near real-time.

II. Procedural History

On May 4, 2015, TDE filed its Original Complaint in the District Court for the Eastern District of Texas against Defendant Moblize, alleging infringement of United States Patent No. 6,892,812 (the "'812 Patent") titled "Automated Method and System for Determining the State of Well Operations and Performing Process Evaluation." (A00018.) On the same day, TDE moved for a preliminary injunction. (A00019.)

Moblize moved to dismiss the lawsuit, claiming that the Patented System is a patent-ineligible abstract idea under *Alice Corp. v. CLS Bank International*, 134 S. Ct. 2347 (2014). (A00021.) Moblize also moved to transfer venue to the pursuant to 28 U.S.C. § 1404(a). (A00021.) The district court granted Moblize's

motion to transfer solely on convenience grounds and transferred the case to the Southern District of Texas, Houston Division. (A00021.)

On September 2, 2015, the district court set a telephonic conference for the following day regarding, *inter alia*, issues related to the preliminary injunction hearing scheduled for September 8, 2015. (A00023.) During the telephonic conference, the court inquired whether counsel would be willing to engage a special master to assist the court with understanding the technology underlying the '812 Patent. (A00023.) Both parties indicated their preference against a special master. (A00023.) The court subsequently vacated the preliminary injunction hearing to be reset on the court's calendar.

On September 11, 2015, the district court granted Moblize's motion to dismiss on the grounds that the '812 Patent lacked eligible subject matter under 35 U.S.C. § 101. (A00024; Memorandum Order and Opinion A00002-A00016.) The court entered final judgment against TDE the same day. (A00001.) TDE timely filed a notice of appeal of the District court's order and final judgment on September 22, 2015. (A00024.)

Statement of the Facts

I. Background of the Relevant Technology

Hydrocarbon wells are drilled by using a drill bit to cut a borehole in the earth. The drill bit is attached to the bottom of a drill pipe. A top drive or a Kelley turns the drill pipe, which is about 30 feet in length. The rotation of the drill pipe also turns the drill bit attached to the bottom of the drill pipe and the drill bit cuts a borehole in the earth. After about thirty feet is drilled, another section of drill pipe is attached and the process continues.

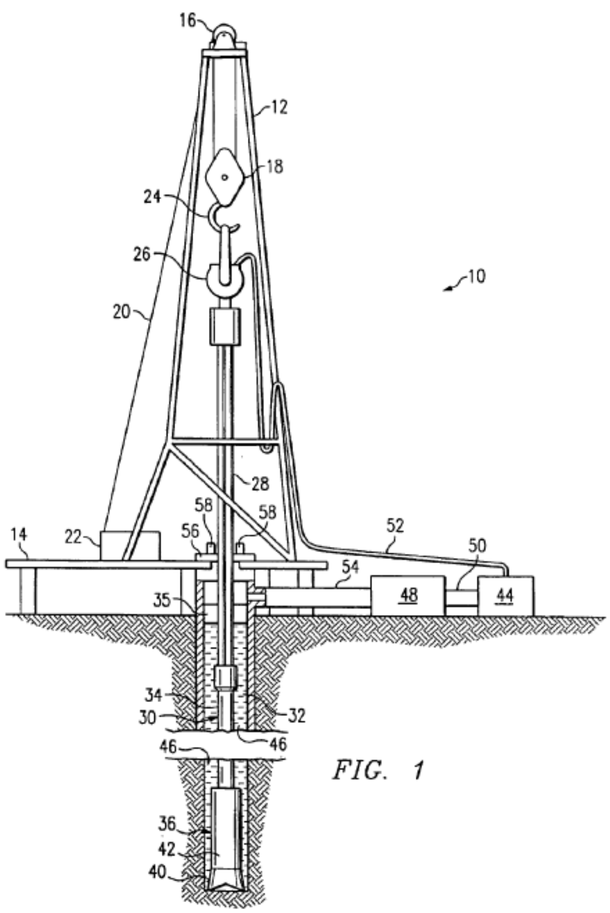


FIG. 1

‘812 Patent Fig. 1 (A00035.)

This connection of each additional length of drill pipe to the top of the drill string is referred to as "making a connection." The drill string is held "in slips" as each additional section of drill pipe is added to the drill string. Mud pumps circulate drilling fluid, generally referred to as "drilling mud," down the drill string and then return it to the mud pits that hold a reservoir of "drilling mud." Thus, drilling mud circulates in a closed loop to remove drill cuttings and cool and lubricate the drill bit. (A00041.) In addition to drilling, i.e. making hole, (making the borehole deeper), there are other well states. Among them are: "tripping," (adding drill pipe to increase the length of the drill string or removing pipe to bring the drill bit back to the surface), washing (removing debris from the borehole), reaming (widening the borehole) or conditioning the borehole (to smooth it) or performing maintenance as well as other well states. (A00041.)

A well state is "an overall conclusion regarding the status of the well operation at a given point in time based on the operation of and/or parameters associated with one or more key drilling elements of the rig. Such elements included the [drill] bit, [drill] string, and drilling fluid." ('812 Patent col. 6 ln. 51-56) (A00043.) Before the '812 Patent, those of ordinary skill in the art might have known that well operations generated substantial amounts of data. However, the industry lacked a means to harness this data to calculate the "real time or near real-time" state of the well. Indeed, "automated management of rig operations [was]

problematic because parameters [could] change quickly and because down hole behavior of drilling elements and down hole conditions may not be directly observable." ('812 Patent, col. 1 ln. 28-32) (A00041.)

As disclosed in the '812 patent, there are sixteen generally accepted well states. (A00038-A00039.) Before the advent of the '812 Patent, automated management of drilling rig operations was problematic because parameters changed quickly and because down hole conditions were not directly observable. In other words, when the drill bit was thousands of feet below the earth's surface, it was impossible for an observer to accurate determine the well state. (A00041.)

It is important to know the state of the well operation in real-time to improve the safety of the oil well. For example, if a driller takes a "kick" of natural gas during drilling, different measures to prevent the gas reaching the surface would be taken depending on the state of the well operation. (A00044.) Phrased differently, different steps are taken to contain or flare the gas depending on the well state and different parameters may indicate a "kick." A recent example of a "kick" of natural gas is the Deep Water Horizon Macondo disaster in the Gulf of Mexico in 2010 where the natural gas "kick" reached the surface, ignited and destroyed the Deepwater Horizon oilrig, killing 11 people. The ensuing fire and loss of control of the well spread millions of barrels of oil along the Gulf Coast. Clearly, well control is vitally important.

Additionally, wells can reach depths in excess of 35,000 feet and take weeks or even months to drill. With costs for some offshore rigs exceeding one million dollars per day, any improvement in the efficiency or safety of the well can have significant cost savings. It takes an average of 17.1 days to drill an onshore hydrocarbon well in the United States. (A01910 at ¶46.) Typically, a single crew works a 12-hour shift before another crew takes its place, different crews drill different sections of each well. In many cases, the operator compares the total number of feet drilled in a 12-hour shift to determine how efficient the driller's crew is. This however is not an accurate measure of a crew's efficiency because the driller may have used part of the 12-hour shift to wash or ream the well or perform maintenance on the drilling equipment, i.e. not drilling. For example, a first crew might drill 100 feet its 12-hour shift and a second crew might drill 200 feet during its 12-hour shift. If both crews are drilling for the entire 12-hour shift, the second crew is twice as efficient as the first crew. However, this is not an accurate comparison because it is unlikely that either crew was drilling for its entire 12-hour shift. For example, a certain amount of the shift is spent making connections, reaming, washing or performing maintenance. None of these well states are "making hole" events that increase the length of the bore hole.

One of the best ways to determine efficiency is to determine the actual time spent making hole. (A00044.) With an accurate real-time well state determination

system, the driller can track exactly how much time the crew has spent rotary drilling, slide drilling, making connections or any of the other 13 well states. If a crew is below acceptable standards, it can be re-trained to improve. In order to determine a crew's true efficiency, it is imperative to know the actual time spent in the well state of "drilling." Even a five to ten percent improvement in efficiency can produce dramatic savings when rig rental rates are tens of thousands (for land rigs) or even multiple millions of dollars per day (for offshore rigs).

For at least these reasons, it is vitally important to accurately determine the state of the well operation automatically and in real-time. Moreover, because wells now reach depths deep below the earth's surface, it is impossible for a human observer on the surface to know with certainty the exact state of the well operation in real-time. As demonstrated by Defendant-Appellee's Motion to Dismiss, a driller can make an educated guess. But the driller has a low chance of accurately determining the actual well state because it will be based on incomplete and inaccurate data.

For example, Defendant-Appellee provided an example of a fictitious human observer named "Drilling Engineer Tom" in its motion to dismiss the Complaint. According to Defendant-Appellee, "Tom," a human, could look at an oil rig and determine the well state. In fact, "Tom" could only speculate and had a 25% chance of accurately determining the well state. (A00709-A00711 – Defendant-

Appellee's fictitious human observer named "Drilling Engineer Tom" only had a 25% chance of accurately determining the well state (A00730-000732).) Rather than relying on guesswork and intuition, drillers began to gather data from a variety of sensors located on and in the well. For example, a rotation sensor could accurately determine if the drill pipe was turning or not. (A00043.) A hydraulic sensor could determine if fluid was flowing and, potentially, the flow rate. (A00043.) However, a variety of other sensors also exist, including seismic and electrical sensing systems. (A00043)

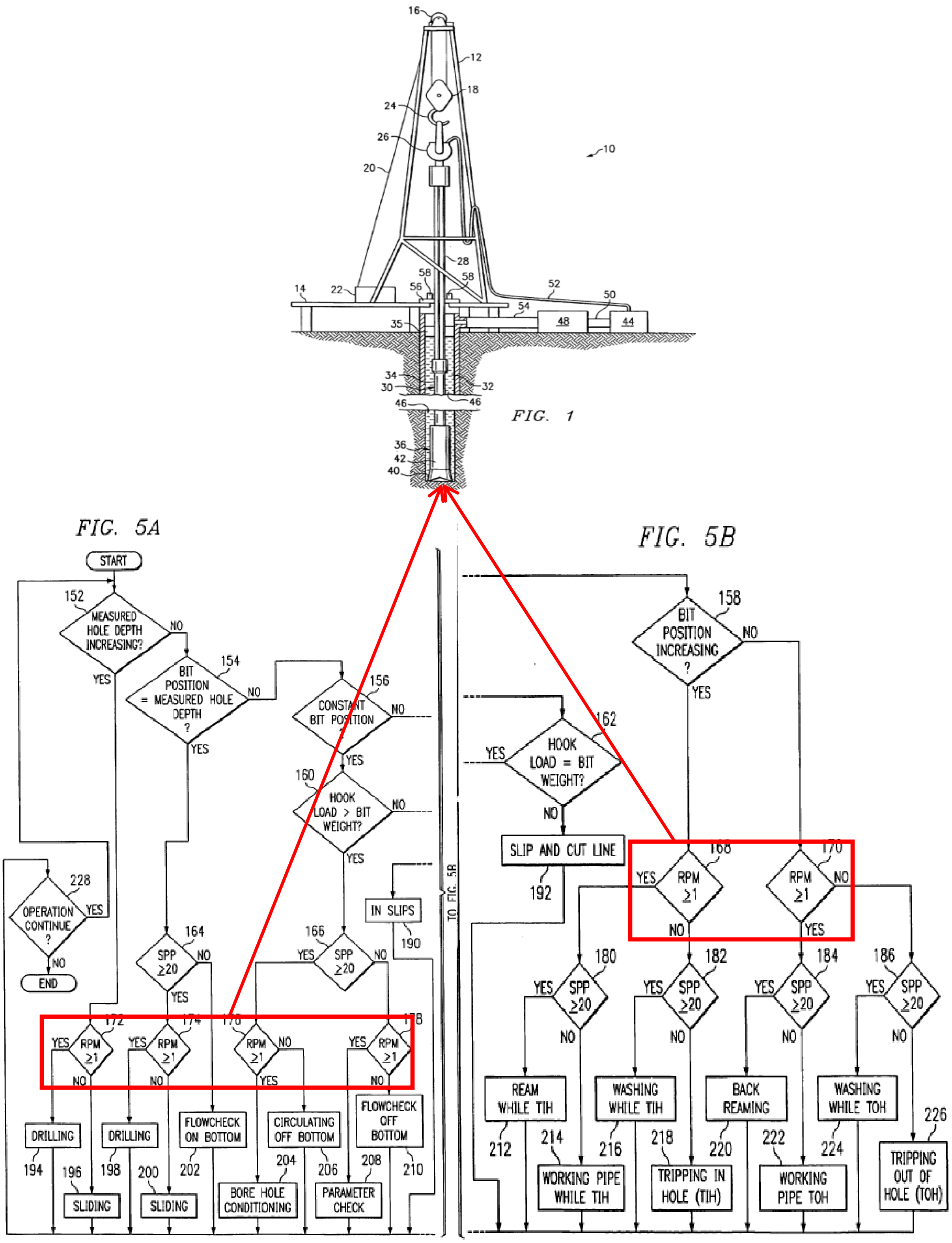
The '812 patent specifically discloses that mechanical and hydraulic data may originate from "any parameter associated with a well operation." Specifically, the '812 patent teaches:

> *"Mechanical data is data related to support or physical action upon or associated with the drill string, bit or any other suitable device associated with the drilling or other operations. Mechanical and hydraulic data may originate with any suitable device operable to accept, report, determine, estimate a value, status, position, movement, or other parameter associated with a well operation. As previously described, mechanical and hydraulic data may originate from machinery sensor data such as motor states and RPM's and for electric data such as electric power consumption of top drive, mud pumps or other satellite equipment. For example, mechanical and/or hydraulic data may originate from dedicated engine sensors, centrifugal on/off sensors, valve position switches, fingerboard open/close indicators, SCR readings, video recognition and any other suitable sensor operable to indicate and/or report information about a device or operation of a system."* ('812 Patent, Col. 5/lines 28-44; A00043.)

Since at least the 1980s, drillers have attempted, with limited success, to automatically determine the state of a well operation. Some early attempts were only able to identify several potential well states, rather than exactly one well state. (A00757-A00775.) Others could only identify a limited number of well states and were useless for accurately determining overall drilling efficiency. *See* Hutchinson, U.S. Patent Publication No. 2005/0060096 (A00810-A00831.) Still others failed to correctly identify the well state at all. *See* Gehrig, U.S. Patent No. 4,610,161 (A00832-A00841.) Some attempts could only indicate whether the well was drilling, but no other state. *See* Crary, U.S. Patent No. 6,237,404 (A00857-A00865.) These systems were used in conjunction with a Measurement-While-Drilling ("MWD") tool that would produce invalid data if the MWD tool was operating while the well was being drilled. Therefore, the well state determination modules used in conjunction with the MWD tools were only useful for determining if a well was "drilling, (i.e. 'making hole')" and to alert the driller that any MWD data gathered would be invalid.

For this reason, no drilling operator could simply look at the instruments on an oil rig and perform a series of "mental steps" to determine the well state. To illustrate, consider the following example where Defendant-Appellee Moblize's hypothetical drilling engineer could observe a single metric – at least one RPM for

this example (surrounded by the red box in Figures 5A and 5B below) – but make an incorrect well state selection without the benefit of other sensor data inputs:



(*See* '812 Patent, Fig. 1, 5A, 5B) (A00035, A00038 and A00039.)

Because this activity takes place "down hole" (indicated here by the arrows), the drilling operator would not be able to directly observe the bit's behavior. (*See id.*) This could easily lead to his selecting "drilling" as the well state incorrectly based on the observable data when it is actually "bore hole conditioning." *Id.* Similarly, as seen in Figures 1, 5A and 5B, a drilling operator could incorrectly select "drilling" as the well state based on the observable data when it is actually "reaming pipe while TIH (tripping in hole)" or "back reaming." *Id.* The '812 Patent was invented to solve this technological gap in the drilling industry by implementing a solution that harnesses mechanical and hydraulic data inputs from sensors on the well operation itself to yield a new and useful result.

The '812 patent solved this problem by harnessing and validating the physical sensory data from the rig to allow a drilling operator to know the well state accurately and in real time. As seen in the '812 patent's file history, the applicants limited all of the claims of the patent to data that had been "validated" by comparison against a limit to determine if the data was accurate. Drilling operators are willing to pay handsomely for a system to automatically determine the "state of the well operation" for their oil rigs because of its value in increasing efficiency and safety. In fact, Plaintiff-Appellant TDE has developed a successful business providing this service. Rather than develop its own well state

determination system, Defendant-Appellant Moblize has copied Plaintiff-Appellant TDE's system and is willfully infringing Plaintiff-Appellant TDE's '812 patent.

II. The '812 Patent

The '812 Patent is directed to a method for providing automated operations recognition technology, also referred to as well state detection. The invention described in the '812 Patent addresses this void in the art by utilizing data collected from the available mechanical and hydraulic sources, whether surface or downhole to provide safer wells and improve the overall efficiency of evaluating productive and non-productive time.

The '812 recites six independent claims and 109 dependent claims, all of which reference well operations technology directly or by necessary implication. As is readily apparent from illustration above, the '812 Patent has no utility apart from a well operation. *See* '812 Patent, Fig. 1 (A00035.) The independent claims provide:

> **1**. An automated method for determining the state of a well operation, comprising:
>
> storing a plurality of states for a well operation;
> receiving mechanical and hydraulic data reported for the well operation from a plurality of systems; and
> determining that at least some of the data is valid by comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data; and

when the at least some of the data are valid, based on the mechanical and hydraulic data, automatically selecting one of the states as the state of the well operation.

31. An automated system for determining the state of a well operation comprising:

means for storing a plurality of states for a well operation;
means for determining that at least some received mechanical and hydraulic data is valid by comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data does not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data; and
means for automatically selecting one of the states based on mechanical and hydraulic data as the state of the well operation when the at least some of the mechanical and hydraulic data are valid.

61. An automated system for determining the state of a well operation, comprising:

logic encoded in media; and
the logic operable to receive mechanical and hydraulic data reported for the well operation from a plurality of systems, determine that at least some of the received data is valid by comparing the at least some of the received data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the received data do not accurately represent the condition purportedly represented by the at least some of the received data, and to automatically select one of the states as the state of the well operation based on the mechanical and hydraulic data when the at least some of the received data are valid.

91. An automated method for determining a state of a drilling operation comprising:

receiving mechanical and hydraulic data reported for a drilling operation;
based on the mechanical and hydraulic data, determining a state of the drilling operation; wherein the state of the drilling operation is determined to be:

drilling if:
a hole is being made; or
a hole is not being made, a drill bit associated with the drilling operation is on bottom and drilling fluid associated with the drill bit is circulating;
testing/conditioning if:
a hole is not being made, the drill bit is on bottom and the drilling fluid is not circulating; or
a hole is not being made, the drill bit is off bottom and the drill bit has a constant position; and
tripping/reaming if:
a hole is not being made, the drill bit is off bottom and the position of the drill bit is not constant.

94. An automated method for determining the state of a well operation, comprising:
storing a plurality of states comprising at least a productive and a non-productive state for the well operation;
receiving mechanical and hydraulic data reported for the well operation; and
determining that at least some of the data is valid by comparing the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data; and
when the at least some of the data are valid, based on the mechanical and hydraulic data, automatically selecting one of the plurality of states as the state of the well operation.

105. An automated system for determining the state of a well operation, comprising:
logic encoded in media; and
the logic operable to receive mechanical and hydraulic data reported for the well operation, determine that at least some of the received data is valid by comparing the data to at least one limit, the at least one limit indicative of a threshold at which at least some of the data do not accurately represent the condition purportedly represented by the at least some of the received data, and to automatically select one of a productive state and a non-productive state as a state of the well operation based on

> the mechanical and hydraulic data when the at least some of the received data are valid.

‘812 Patent, cl. 1, 31, 61, 105 (A00048-A00051.)

Each of the dependent claims solidifies the invention’s integration into the well operation by specifying the method and system claims’ applicability to particular well states – i.e. (1) rotary drilling, (2) sliding drilling, (3) flow check on bottom, (4) bore hole conditioning, (5) circulating off bottom, (6) parameter check, (7) flow check off bottom, (8) reaming while tripping in hole, (9) working pipe while tripping in hole, (10) washing while tripping in hole, (13) tripping in hole, (14) working pipe while tripping out of hole. (15) in slips and, (16) slip and cut line. (*See* ‘812 Patent cl. 2–21, 32–51, 58, 62–81, 89, 92-93, 95-104, 106-115.) (*id.*)

Further, dependent claims 30, 60 and 90 recite “using the state of the well operation to evaluate parameters and ***provide control for the operation***.” (*See* ‘812 Patent cl. 30) (emphasis added) (A00049-A00050.) Dependent claim 60 depends from system claim 31 and is drafted in means-plus-function language and includes a “means for . . . evaluat[ing] parameters and provid[ing] control for the operation” that may correspond to the “well control sub-module 88” structure recited in the specification:

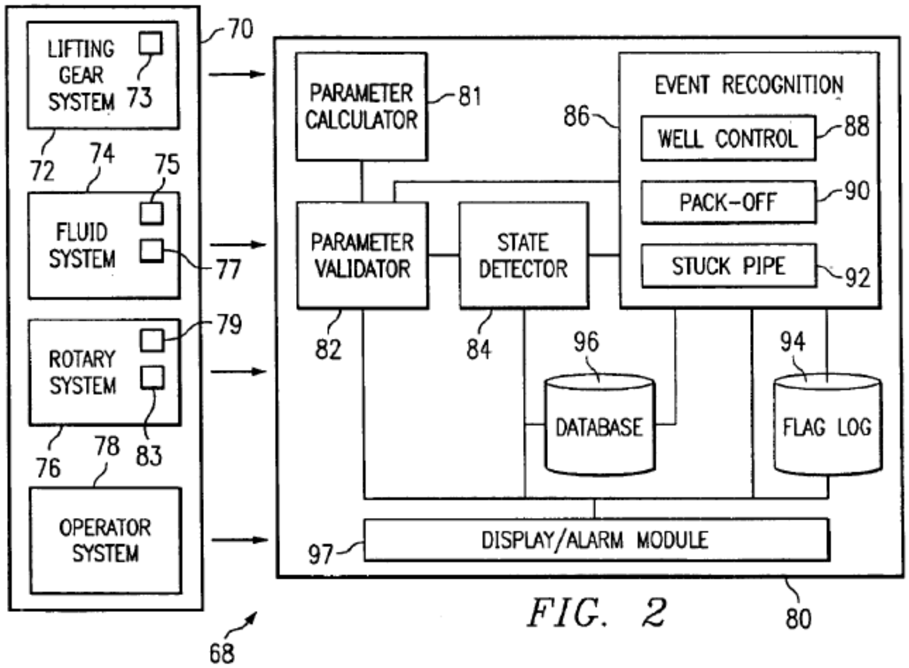


FIG. 2

(*See* '812 Patent col. 7 ln. 37-56, Fig. 2.) Claim 90 depends from system claim 61, which utilizes "logic encoded in media" that is "further operable . . . to evaluate parameters and provide control for the operation." The patent teaches that the "logic may comprise software stored on a computer-readable medium for use in connection with a general purpose processor, or programmed hardware such as application-specific integrated circuits (ASIC), field programmable gate arrays (FPGA), digital signal processors (DSP) and the like." ('812 Patent col. 6 ln. 11-16) (A00043.)

III. Prosecution History

During the '812 Patent's prosecution history, the applicants amended the original claims to overcome a rejection in light of U.S. Patent No. 4,825,962, which the Examiner believed taught well state determination, U.S. Patent No.

4,875,530, which the Examiner asserted "discloses well state identification," and Society of Petroleum Engineers ("SPE") Paper 30523 (March 22, 1995, over which the Examiner concluded "the claimed invention cannot be considered novel." (*See* A00505 and A00541.) After the applicants amended the claims to recite "determining if at least some of the data is valid by comparing at least some of the data to at least one limit," the Examiner allowed the claims. (A00622.)

Summary of the Argument

The District Court erred in holding Plaintiff-Appellant's patent ineligible under § 101 and dismissing its Complaint with prejudice.

First, the Court failed to correctly apply the Supreme Court's two-part test articulated in *Alice Corp. v. CLS Bank International* and *Mayo Collaborative Services v. Prometheus Laboratories, Inc.* The District Court incorrectly identified the core concept underlying the '812 Patent's claims as "the simple steps of storing data, receiving data, and using mathematics or a computer to organize that data and generate additional information." (Order at p. 8; A00009.) This oversimplification infected its entire analysis and predictably resulted in the Court's finding the '812 Patent lacked an inventive concept. Properly considered, the '812 Patent is directed to a practical application for transforming data representative of the physical state of an oil rig into a different state – the state of the well operation. The patented method harnesses the sensors and systems directly integrated to the well operation itself in order to provide real time process evaluation and well control. It is thus not abstract, but concrete.

Second, the District Court erred by discounting the meaningful limitations claimed by the '812 Patent's process and machine for providing well state detection. Far from "cover[ing] practically any system for determining the state of well operation," (Order at p. 10; A00011), the '812 Patent is directed to the

particular method and systems disclosed. Had the District Court engaged in claim construction, it would have realized that there were a finite number of well states and systems known at the time of the '812 Patent's application that largely carried standardized meanings to those of ordinary skill in the art. Moreover, some of the '812 Patent's claims are drafted in means-plus-function language, thus further limiting them to the particular structures disclosed in the specification and their equivalents at the time of application.

Third, the District Court failed to faithfully apply the proper standard for ruling on a Rule 12(b)(6) motion and to accept as true all well-pleaded allegations. In particular, Plaintiff-Appellant pled that it held a valid and enforceable patent. (Complaint ¶8; A00027.) Yet, the District Court apparently accepted contrary attorney argument from Defendant-Appellee Moblize that the '812 Patent unduly preempts the field of use and simply teaches functions that are routine, conventional and well-known in the relevant industry – without any factual support. This, it cannot do on the pleadings and alone should mandate reversal. Even so, the references offered in support of Defendant's invalidity contentions and the prosecution history of the '812 Patent itself squarely rebut any contention that the '812 Patent preempts all well state detection or fails to disclose an inventive concept in the combination of its elements.

This Court should reverse the District Court's ruling and find that the '812 Patent is directed to statutory subject matter under 35 U.S.C. § 101.

Argument

This is a case of first impression before this Court in the post-*Alice* world. *Alice* and its progeny have predominantly focused on patents directed to methods for conducting e-commerce on the Internet. But since the Supreme Court's decision in *Alice v. CLS Bank*, this Court has not reviewed an eligibility determination of a patent in which sensor data representative of the physical state of a machine is transformed to control the machine and to improve the machine's safety and efficiency. Such a process is firmly rooted in statutory subject matter under this Court and the Supreme Court's long-standing precedent.

In the present case, the Complaint has been dismissed and U.S. Patent No. 6,892,812 held to lack patent-eligible subject matter. Under Section 101 and the cases construing that section, however, the '812 patent would lack patent-eligible subject matter only if it is both "abstract" and lacking "an inventive concept" before determining that it is "patent-ineligible." As explained below, U.S. Patent No. 6,892,812 is not abstract and has an inventive concept. Therefore, the '812 Patent is drawn to patent-eligible subject matter pursuant to 35 U.S.C. §101, and the District Court's conclusion to the contrary should be reversed.

I. Standard of Review

The Federal Circuit reviews a district court's dismissal for failure to state a claim under the regional circuit law in which the district court sits. *OIP Techs.,*

Inc. v. Amazon.com, Inc., 788 F.3d 1359, 1362 (Fed. Cir. 2015). The Fifth Circuit reviews *de novo* a district court's grant of a motion to dismiss "accepting all well-pleaded facts as true and viewing those facts in the light most favorable to the plaintiff." *Bustos v. Martini Club Inc.*, 599 F.3d 458, 461 (5th Cir. 2010) (quotation marks omitted). "Patent eligibility under 35 U.S.C. § 101 is an issue of law reviewed *de novo*." *OIP Techs*., 788 F.3d at 1362.

II. The '812 Patent's Subject Matter Eligible for Patent Protection

"Section 101 of the Patent Act defines the subject matter eligible for patent protection." *Alice Corp. Pty. Ltd. v. CLS Bank Int'l*, 134 S. Ct. 2347, 2354 (2014). "A patent may be obtained for 'any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof.'" *OIP Techs*., 788 F.3d at 1362 (quoting 35 U.S.C. § 101). Here, the '812 Patent comfortably fits into the statutory categories eligible for patent under § 101 because it claims a process and machine for determining the state of a well operation and performing process evaluation. ('812 Patent Col. 1 ln. 1-4) (A00041.)

The only dispute is whether the '812 Patent falls into one of three judicially-created exceptions to patent eligibility: "laws of nature, natural phenomena, and abstract ideas." *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 132 S. Ct. 1289, 1293 (2012) (quoting *Diamond v. Diehr*, 450 U.S. 175, 185 (1981)). Courts

must take care when applying these non-statutory exceptions to § 101, however, as "too broad an interpretation of this exclusionary principle could eviscerate patent law. For all inventions at some level embody, use, reflect, rest upon, or apply laws of nature, natural phenomena, or abstract ideas." *Mayo*, 132 S. Ct. at 1293.

In *Mayo* and *Alice*, the Supreme Court articulated a two-step framework for assessing patent eligibility. *Alice*, 134 S. Ct. at 2355; *Mayo*, 132 S. Ct. at 1293. First, the court must "determine whether the claims at issue are directed to one of those patent-ineligible concepts." *Alice*, 134 S. Ct. at 2355. If so, the court will then consider "whether the additional elements 'transform the nature of the claim' into a patent-eligible application." *Id.* "This is the search for an 'inventive concept'—something sufficient to ensure that the claim amounts to 'significantly more than the abstract idea itself." *Content Extraction and Transmission LLC v. Wells Fargo Bank, N.A.*, 776 F.3d 1343, 1347 (Fed. Cir. 2014).

The '812 Patent is not abstract, but indeed a concrete method and system for harnessing data representative of a physical state to determine the state of a well operation, to control the well operation and to improve the well operation's safety and efficiency.

A. The '812 Patent Claims the Tangible Subject Matter of An Oil Rig with Mechanical and Hydraulic Sensors, Data Validation Means, Means for Determining if the Drill Bit is On Bottom, a Drilling Fluid and a Drill Bit

The '812 Patent-in-Suit is not abstract because it claims transforming sensor data, representative of a physical object, into another state. The abstract idea exclusionary rule precludes extending patent protection to "[a] principle, in the abstract, . . . a fundamental truth; an original cause; a motive." *Diehr*, 450 U.S. at 185 (quoting *Le Roy v. Tatham*, 14 How. 156, 175 (1853)). In *Alice*, the Supreme Court declined to further "delimit the precise contours of the 'abstract ideas' category," leaving it to be defined on a case-by-case basis by the lower courts. *See Alice Corp.*, 134 S.Ct. at 2357. But two distinct trends have emerged from the *Alice* line of cases to define the requirements of § 101.

The first line of cases has found claimed processes directed to business methods to encompass an "abstract idea" where they described methods of organizing human activity in the e-commerce space.[1] The second line of cases has

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[1] *See, e.g., Alice*, 134 S.Ct. at 2356 (finding a method for exchanging financial obligations between two parties using a third-party intermediary to mitigate settlement risk (the idea of intermediated settlement) an abstract idea); *Bilski v. Kappos*, 561 U.S. 593, 609 (2010) (finding a method for hedging against the financial risk of price fluctuations an abstract idea); *Ultramercial, Inc. v. Hulu, LLC*, 772 F.3d 709, 714-15 (Fed. Cir. 2014) (finding a method for displaying an advertisement in exchange for access to copyrighted media (the idea of using an advertisement as an exchange or currency) an abstract idea); *buySAFE v. Google, Inc.*, 765 F.3d 1350, 1352 (Fed. Cir. 2014) (finding a method by which a third

found that claims whose processes include mathematical equations or scientifically discovered chemical or physical relationships encompass a patent-ineligible category, although it is not entirely clear from the Court's respective analyses whether the relevant category in such cases is "abstract ideas" or instead "laws of nature."[2] The common thread throughout both lines of cases is that all of the claimed processes dealt with data transformation regarding intangible abstract economic concepts or laws of nature.

The '812 Patent, on the other hand, claims transforming sensor data, representative of a physical object, into another state and is therefore significantly distinguishable from the recent raft of business method patents held ineligible.

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party can guarantee a sales transaction an abstract idea); *Dealertrack, Inc. v. Huber*, 674 F.3d 1315, 1333 (Fed. Cir. 2012) (finding a method for processing information through a clearinghouse was an abstract idea).

[2] *See, e.g., Mayo,* 132 S.Ct. at 1293 (finding that a claim describing relationships between concentrations of certain metabolites in the blood and the likelihood that a dosage of a drug will cause harm set forth laws of nature); *Parker v. Flook,* 437 U.S. 584, 586 (1978) (finding a claim for a method of computing an alarm limit in the catalytic conversion of hydrocarbons using a mathematical algorithm included a law of nature); *Gottschalk v. Benson,* 409 U.S. 63, 71-72, 93 S.Ct. 253 (1972) (finding a claim for a method of converting binary-coded decimal numerals into pure binary numerals using a mathematical formula in a general-use computer was a claim on an idea).

1. The ‘812 Patent Is Directed to Transforming Sensor Data from a Machine to Determine the State of the Machine, to Control the Machine and to Improve the Machine’s Safety and Efficiency

The claims of the ‘812 Patent include at least (1) an oil rig or well operation, (2) mechanical and hydraulic sensors, (3) data validation, (4) sensors for determining the drill bit’s position, (5) determining the flow rate of the drilling fluid being pumped and (6) a drill bit. In other words, the claims implicate at least six real-world physical devices, the measurement of these physical devices, using mechanical and hydraulic sensors transforms this data representative of the operations of these devices into another state—namely, the state of the well operation. For example, raw mechanical data indicating that the drill string is turning at 50 rotations per minute or raw hydraulic data that the drilling fluid pumps are pumping at 200 gallons per minute is automatically transformed into a validated determination of the state of the well, i.e. whether the well operation is “productive” or “unproductive.”

This provides a technical advantage of automatically determining in real time if the well is productive or unproductive - as well as providing an automated method and system for effectively determining the state of the well operation in real-time. For example, the invention allows the well operator to know whether the oil rig is indeed drilling, tripping, reaming, testing or conditioning. In certain embodiments, the state of a rig is determined in real time and used for reporting,

event recognition or rig management. (*See* '812 patent, Col. 2 ln. 1-8) (A00041.) These embodiments can be thought of as a closed-loop system where the transformed data is used to control and alter the operation of the oil rig.

This Court has historically upheld processes under § 101 involving "transformations or manipulations . . . of . . . physical objects or substances [or that] are . . . representative of physical objects or substances." *In re Bilski*, 545 F.3d 943, 963 (Fed. Cir. 2008) *aff'd but criticized sub nom. Bilski v. Kappos*, 561 U.S. 593 (2010); *In re Abele*, 684 F.2d 902, 909 (C.C.P.A. 1982), *"Freeman-Walter-Abele test"* is no longer the sole test of patent-eligibility, *In re Bilski*, 545 F.3d at 963[3] ("If it appears that the mathematical algorithm is implemented in a specific manner to define structural relationships between the physical elements of the claim (in apparatus claims) or to refine or limit claim steps (in process claims), the claim being otherwise statutory, the claim passes muster under s 101."); *see also In re Schrader*, 22 F.3d 290 (Fed. Cir. 1994) (holding that the claims were not patent-eligible because they did "not reflect any transformation or conversion of subject matter representative of or constituting physical activity or objects.").

[3] In *Bilski*, this Court abrogated *In re Abele* to the extent that *Abele* suggested that the only measure of eligibility under § 101 was "determining whether [an] algorithm is 'applied in any manner to physical elements or process steps.'" *See* 545 F.3d at 959, 963 (noting that in *Abele*, "the transformation of that raw data into a particular visual depiction of a physical object on a display was sufficient to render that more narrowly-claimed process patent-eligible"). Thus, transforming raw data into a visual depiction of a physical object was patent-eligible.

The ‘812 Patent claims systems and methods that transform data representative of the physical state of the well into a comprehensible depiction of the well state that can be used for process evaluation or well control. In this way, the ‘812 Patent’s claims are similar to the patent at issue in *Diamond v. Diehr*. There, the Supreme Court held that a process for curing rubber using a computer was patent eligible subject matter. In finding the curing process was not abstract, the Court explained:

> The respondents here do not seek to patent a mathematical formula. Instead, they seek patent protection for a process of curing synthetic rubber. Their process admittedly employs a well-known mathematical equation, but they do not seek to preempt the use of that equation. Rather, they seek only to foreclose from others the use of that equation in conjunction with all of the other steps in their claimed process. These include installing rubber in a press, closing the mold, constantly determining the temperature of the mold, constantly recalculating the appropriate cure time through the use of the formula and a digital computer, and automatically opening the press at the proper time. Obviously, one does not need a ‘computer’ to cure natural or synthetic rubber, but if the computer use incorporated in the process patent significantly lessens the possibility of “overcuring” or “undercuring,” the process as a whole does not thereby become unpatentable subject matter.

Id. at 187-88.

The ‘812 patent claims are analogous to the subject matter of the patent claims in *Diamond v. Diehr* because the ‘812 patent claims receive data and transform it in an analogous way. Diehr’s claim receiving data about the temperature in the rubber press (a physical real-world parameter); the ‘812 patent

claims receiving data from mechanical and hydraulic sensors. In other embodiments, the claims require determining the position of the drill bit (claims 23[drill bit on bottom] and 25[drill bit position constant]) and determining if the drilling fluid is circulating (claim 24). Each of these physical devices will be discussed in turn.

Comparison of the Claims of *Diehr* and '812 Patent-In-Suit	
Diehr Patent – method of curing rubber	'812 Patent – automatic system and method for determining the state of a well operation
Installing rubber in a press and closing the mold	Storing a plurality of well states for a well operation;
constantly determining the temperature of the mold (a temperature sensor in the form of an embedded thermocouple) reports the temperature of the mold and reports this data to the computer)	Receiving mechanical and hydraulic data reported for the well operation (sensors report physical state of rig/well components, e.g. rotation sensor is 50 RPM's, Stand Pipe Pressure is 200 psi);
and automatically opening the press at the proper time. (when the state of the mold is "cured," the press opens.)	Selecting one of the states as the state of the well operation. (When the well state is determined, this can be used to report well state or even control the well.)

The '812 Patent's specification discloses that "mechanical data is related to support or physical action upon or of the drill string, bit or any other suitable device associated with the drilling or other operation." ('812 Patent, col. 5 ln. 28-31) (A00043.) An example of mechanical data is the Rotations Per Minute (RPM) of the drill string. If the RPM are greater than one, the drill string is rotating. Other examples of mechanical data are "hook load" and "bit position." These parameters indicate the "load on the hook" and the "position of the drill bit in the

borehole," respectively. Similarly, hydraulic data is: "related to flow, volume, movement, rheology, and other aspects of drilling or other fluid performing work or otherwise used in operations." ('812 Patent, col. 5 ln. 24-28) (A00043.) An example of hydraulic data is Stand Pipe Pressure (SPP). Under normal drilling conditions, when SPP is greater than 20 pounds per square inch (psi), the drilling pumps are "on" and drilling fluid is "circulating." Phrased differently, the mechanical and hydraulic data are signals representative of the reported value of the machinery operating as part of the oil rig. Similarly, data validation confirms that the mechanical and hydraulic data reported is within expected limits. For example, a negative SPP (Stand Pipe Pressure) could indicate that the hydraulic sensor is uncalibrated, has failed, or is in the process of failing.

The fourth step of the '812 Patent claim recites "automatically selecting one of the states as the state of the well operation." The state of the well operation is the physical state of the oil rig/well. As discussed above, because the drill bit can be thousands of feet below the earth's surface, it can be unworkable and impossible for a human observer to determine the well state. Further, accurately determining the "state of the well operation" can be vital to improve the safety and an operational efficiency of the oil rig.

In addition to the process claimed in the independent claims of the '812 patent, the dependent claims disclose "controlling of the well operation" (claims

30[4], 60[5], and 90[6]), using the "determined state of the well operation." Phrased differently, claims 30, 60 and 91 recite a closed-loop system in which the system collects physical data, determines the state of the well operation and modifies the operation of the well based on the well state.

Far from an "abstract" concept, the '812 patent teaches and claims a closed-loop oil rig that significantly improves the efficiency and safety of the well operation. The '812 Patent's transformation of raw data representative of the physical state of the well operation thus removes it from the realm of abstraction and into the physical world.

2. The '812 Patent Does Not Claim a Fundamental Building Block of Human Ingenuity or Basic Tool of Scientific and Technological Work

Preemption is "the concern that drives [the abstract concept] exclusionary principle." *Alice*, 134 S.Ct. at 2354; *Cal. Inst. of Tech. v. Hughes Communs., Inc.*, 59 F. Supp. 3d 974, 990 (C.D. Cal. 2014) "[T]he concern underlying § 101 is

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[4] Claim 30 recites: "The method of claim 1, further comprising using the state of the well operation to evaluate parameters ***and provide control for the well operation.***"(emphasis added)
[5] Claim 60 recites: "The method of claim 31, further comprising means for using the state of the well operation to evaluate parameters ***and provide control for the operation.***" (emphasis added)
[6] Claim 90 recites: The system of claim 61, the logic further operable to use the state of the well operation to evaluate parameters ***and provide control for the operation.***" (emphasis added)

preemption [–] the idea that allowing a patent on the invention will impede innovation rather than incentive it.”). The District Court incorrectly held that the ‘812 Patent is directed to an abstract concept consisting of “the simple steps of storing data, receiving data, and using mathematics or a computer to organize that data and generate additional information.” (Order at p. 8) (A00009.) Using this simplistic reasoning, the Court found that the patent “covers practically any system for determining the state of well operation.” (Order at p. 10) (A00011.) It does not, for several reasons.

First, the District Court’s analysis ignores one of the‘812 Patent’s prime features – that it relies on mechanical and hydraulic sensor data representative of the physical state of the well operation to select the well state in real time. This Court’s *Digitech Image Technologies* opinion (relied on by the District Court) illustrates the significance of this distinction between simple data processing and the invention claimed by the patent-in-suit. In *Digitech*, this Court held that the claims “recite[d] an ineligible abstract process of gathering and combining data ***that does not require input from a physical device***.” *Digitech Image Techs., LLC v. Elecs. for Imaging, Inc.*, 758 F.3d 1344, 1351 (Fed. Cir. 2014) (emphasis added). It further noted that the claimed method relied on “taking existing information” and was not “expressly tie[d] . . . to an image processor” device. *Id.*; *see also Content Extraction*, 776 F.3d at 1349 (noting “abstract idea of extracting and

storing data from hard copy documents using generic scanning and processing technology”). By contrast, the ‘812 Patent relies on “receiving mechanical and hydraulic data reported ***for the well operation from a plurality of systems***” to select the well state in real time. (*See* ‘812 Patent cl. 1)(A00048) (emphasis added). It is therefore distinct from the basic abstract principle of “storing data, receiving data, and using mathematics or a computer to organize that data and generate additional information.” (Order at p. 8)(A00009.)

Additionally, the District Court failed to articulate a “fundamental building block[] of human ingenuity or basic tool[] of scientific and technological work” that would supposedly be impeded by the ‘812 Patent, apart from acknowledging the breadth of its claims. The Court must perform a preemption analysis and determine whether the remainder of the claim includes limitations that “narrow, confine, or otherwise tie down the claim so that, in practical terms, it does not cover the full abstract idea itself.” *Accenture,* 728 F.3d at 1341. “[T]he relevant inquiry is whether a claim, as a whole, includes meaningful limitations restricting it to an application, rather than merely an abstract idea.” *Ultramercial,* 722 F.3d at 1344 (citing *Mayo,* 132 S. Ct. at 1297).

Here, the ‘812 patent-in-suit’s elements are drawn to a (a) storing a plurality of well states for a well operation; (b) receiving mechanical and hydraulic data reported for the well operation from a plurality of systems; and,(c) determining that

at least some of the data is valid by comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data ; and when the at least some of the data are valid, based on the mechanical and hydraulic data, (d) automatically selecting one of the states as the state of the well operation. Defendant-Appellee made no effort to show that these ideas are fundamental truths or fundamental principles the patenting of which would pre-empt the "use of basic tools of scientific and technological work." In fact, the Record is devoid of support for whether "well state detection" even qualifies as an abstract concept, such that its use would pre-empt the "basic tools of scientific and technological work." However, Defendant-Appellee has provided no support for the position that "well state determination" is ubiquitous in well operations. Nor did the District Court cite any authority for this proposition in its Order – other than Defendant-Appellee's motion.

Defendant-Appellee's own expert witness for the preliminary injunction motion in the District Court identified several references alleged to disclose well state determination. (*See* Defendant-Appellant's Invalidity Contentions (A02074-A02297) and the Defendant-Appellee's Expert Report of James W. Williams Regarding Invalidity (A01403-A01898.) Defendant-Appellee identified SPE

Papers SPE 5789[7], and SPE 24272[8], as prior art well state detection systems. In addition, Defendant-Appellee Moblize also identified U.S. Patent Application No. 2005/0060096[9], as a further "prior art" well state detection reference. All of these references refute the idea that the '812 patent-in-suit has "preempted" well state detection. In fact, Defendant-Appellee asserts that there are more than 150 prior art well state detection references. (A02274-A02297.) It is hard to believe that the area of "well state detection" is "preempted" and a "fundamental building block of human ingenuity or a basic tool of scientific and technical work" has been preempted by the '812 patent-in-suit in light of this universe of references that per se are not preempted by the '812 patent-in-suit.

B. The '812 Patent's Claims Include an "Inventive Concept"

Even assuming *arguendo* that the '812 Patent is drawn to "an abstract concept," the claims contain meaningful limitations that represent a patent-eligible application of the idea that harnesses the systems and sensors on the well operation itself. This second step in the patent eligibility analysis searches for an "inventive concept," which requires the Court to "consider the elements of each claim—both

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[7] "Intelligent Real-Time Status Analysis for Rig-Site Drilling Engineering, Parigot P. et al., Offshore Technology Conference, May 2-5, 1988. (A01404)

[8] "Real-Time Expert Systems for Drilling Operations Support," Society of Petroleum Engineering, May 25-27, 1992 (A01468)

[9] Hutchinson, "Method for Improving Drilling Depth Measurements." (A01471)

individually and as an ordered combination—to determine whether the additional elements transform the nature of the claim into a patent-eligible application of that abstract idea." *DDR Holdings*, 773 F.3d at 1255 (quoting *Alice*, 134 S. Ct. at 2355). An "inventive concept" derives from "an element or combination of elements that is sufficient to ensure that the patent in practice amounts to significantly more than a patent upon the ineligible concept itself." *Alice*, 134 S.Ct. at 2335.

1. The *Alice* Court's Interpretation of *Diamond v. Diehr* Confirms that '812 Patent-in-Suit is "Significantly More" than the Abstract Idea of "Well State Determination" and is therefore a Patent-Eligible "Inventive Application" of "Well State Determination"

A unanimous Court in *Alice* reaffirmed the rule in *Diamond v. Diehr* that a patent-ineligible abstract idea could be patent-eligible if the claims included an "inventive concept" that "transformed the process into an inventive application" of the abstract idea. Specifically, the *Alice* Court observed:

> In *Diehr* . . . we held that a computer-implemented process for curing rubber was patent eligible, but not because it involved a computer. The claim employed a 'well-known' mathematical equation, but it used that equation in a process designed to solve a technological problem in 'conventional industry practice.' *Id.*, at 177, 178, 101 S.Ct. 1048, 67 L.Ed.2d 155. The invention in *Diehr* used a 'thermocouple' to record constant temperature measurements inside the rubber mold--something ' the industry ha[d] not been able to obtain.' *Id.*, at 178, 101 S.Ct. 1048, 67 L.Ed.2d 155, and n. 3. The temperature measurements were then fed into a computer, which repeatedly recalculated the remaining cure time by using the mathematical equation. *Id.*, at 178-179, 101 S.Ct. 1048, 67 L.Ed.2d 155. These

> additional steps, we recently explained, 'transformed the process into an inventive application of the formula.' *Mayo*, supra, at ___, 132 S.Ct. 1289, 182 L.Ed.2d 321, 337). In other words, the claims in *Diehr* were patent eligible because they improved an existing technological process, not because they were implemented on a computer.

Alice, 134 S.Ct. 2358.

The '812 Patent's claims are analogous for several reasons. First, the Diehr patent employed a thermocouple sensor to send temperature data to a computer. The '812 Patent claims "receiving mechanical and hydraulic data reported for the well operations." This is analogous because both the Diehr and '812 Patent require receiving data from a sensor.

Second, both the Diehr patent and the '812 Patent require that the sensor measurements be "fed into a computer." *See Diehr*, 450 U.S. at 178; *see also* '812 Patent Cl. 61 ("the logic operable to receive mechanical and hydraulic data reported for the well operation from a plurality of systems") (A00049.)

Third, according to the '812 patent, the computer automatically determines the state of the well operation, "based on the mechanical and hydraulic data." *See, e.g.*, '812 Patent cl. 1 (A00048.) Similarly in *Diehr*, the computer calculated whether the rubber was cured or uncured based on the temperature data from the thermocouple sensor. *See Diehr*, 450 U.S. at 178. The process continued until the computer had determined that the rubber was indeed cured, based on the on the temperature data reported by the thermocouple sensor. This state determination

process directly corresponds to the ‘812 Patent’s process for well state selection. The Diehr patent required a determination based on the thermocouple sensor’s received data that the state of the rubber is either cured or uncured while the ‘812 patent similarly selects the state of the well operation based on mechanical and hydraulic data – e.g., whether the well operation is currently in a productive or unproductive state. *See*‘812 Patent cl. 94 (A00050.)

The ‘812 Patent’s claims are thus directly comparable to the claims of the Diehr patent found to be eligible under § 101.

2. The ‘812 Patent’s Claims Build and Improve Upon Existing Technological Process in Well State Detection to Supply an Inventive Concept for the Invention

The ‘812 Patent’s claims contain meaningful limitations that represent a patent-eligible application of the idea that harnesses the systems and sensors of the well operation itself. An “inventive concept” “can be established by something more than ‘conventional functioning’ that targets and improves existing technological processes for a specific problem in field of the invention.” *Ameritox, Ltd. v. Millennium Health, LLC*, 2015 U.S. Dist. LEXIS 19665, at *68-70 (W.D. Wis. Feb. 18, 2015) (holding that a method for urine screening that combined otherwise conventional steps to offer more accurate detection data was patent eligible because it “solve[d] a unique problem with respect to drug testing technology”). For instance, a new method for data transmission or novel use of a

device itself to accomplish a new and useful result may prove sufficiently transformative. *See, e.g.*, *Fairfield Indus., Inc. v. Wireless Seismic, Inc.*, No. 4:14–CV–2972, 2014 WL 7342525 (S.D. Tex. Dec. 23, 2014) (denying motion to dismiss because "the use of a string of seismic acquisition units and different transmission parameters constitute inventive concepts that transcend the abstract idea of a relay" and noting that the "claim's close connection to a specific machine . . . further supports a finding of patent-eligibility"); *Wavetronix LLC v. Iteris, Inc.*, No. A–14–CA–970–SS, 2015 WL 300726 (S.D. Tex. Jan. 22, 2015) (finding an inventive concept with the claimed method used the existing sensors mounted on a traffic light to calculate a "dilemma zone").

Despite the relatively narrow holding in *Alice* – that abstract business methods do not become automatically patentable when implemented on a computer – it has unleashed a raft of decisions invalidating software patents. *See, e.g.*, *Intellectual Ventures I LLC v. Capital One Bank (USA)*, 792 F.3d 1363, 1368 n.2 (Fed. Cir. 2015). Even so, it is clear that "computer software and codes remain patentable." *Cal. Institute of Tech. v. Hughes Comm'ns., Inc.*, 59 F. Supp. 3d 974, 990 (C.D. Cal. 2014). A bright-line rule that would exclude an entire category of method patents "contradicts Congress's actions [in the recently-enacted America Invents Act] and the Supreme Court's guidance that software may be patentable if it improves the functioning of a computer." *Cal. Tech.*, 59 F. Supp. 3d at 987.

The role of a computer may thus provide the requisite inventive concept if it "involve[s] more than performance of 'well-understood, routine, [and] conventional activities previously known to the industry.'" *Content Extraction*, 776 F.3d at 1347-48 (quoting *Alice*, 134 S.Ct. at 2359). Thus, claims that "specify how interactions . . . are manipulated to yield a desired result . . . that overrides the routine and conventional sequence of events" describe patentable subject matter." *DDR Holdings*, 773 F.3d at 1255. The "court must also consider claim elements as a combination. A combination of conventional elements may be unconventional." *Cal. Tech.*, 59 F. Supp. 3d at 992; *see also Diehr*, 450 U.S. at 188 ("[A] new combination of steps in a process may be patentable even though all the constituents of the combination were well known and in common use before the combination was made.").

In this step of the analysis, the Court may look to the specifications in the patent to assess whether it improves upon existing processes and conventions. *See Mobile-Plan-it LLC v. Facebook Inc.*, No. 14-cv-1709-RS, 2015 WL 1801425, at *3 (N.D. Cal. Apr. 20, 2015) (denying Rule 12(c) motion because the claims and specifications disclosed a technical solution to a problem arising specifically in the email communications environment); *Ameritox*, 2015 U.S. Dist. LEXIS 19665, at *69-70 n.23 (relying on specification that identified problem in the field to find inventive concept in the solution the patent provided).

a. The Integral Relationship Between the Combination of the '812 Patent's Method and the Individual Components of An Oil Rig Transform It Into An Inventive Concept Outside of the Scope of the *Alice* Case

The inventive concept behind the '812 patent's claims stems from its combination of elements: (1) storing well states; (2) receiving mechanical and hydraulic data from sensors in the well operation; (3) verifying the data against thresholds; and (4) automatically selecting a well state. Together, the asserted claims yield a new and useful application to well state recognition. Broadly speaking, the inventors recognized that vast amounts of sensor data were being gathered. Rather than considering each stream of data separately, the inventors recognized that after verifying the data against a threshold, it could be used to "select" one of the "states" as the "state of the well operation." In addition, this insight allowed a user to recognize productive and non-productive activity. (*See* '812 Patent, cl. 105) (A00050-A00051.) This would allow a user to recognize activity that had previously been characterized as productive, when it was actually non-productive activity.

As the Patent discloses, its technological advantage over preexisting well operations management systems is its ability to determine well states in or near real time to provide process evaluation and well control. *See* '812 Patent, col. 2 ln 4-7 (A00041.) Thus, whether a human can perform the task with pencil and paper is

"unhelpful" to this particular analysis. *See Cal. Tech.*, 59 F. Supp. 3d at 994. Even if a person could put pen to paper to somehow replicate the '812 Patent's method, "[a]t the end of the effort, he would be left with a lot of paper that obviously would not produce the same result." *Id.* As demonstrated above, a hypothetical drilling engineer would be unsuccessful in identifying all the possible wells states and also failed to accurately identify the actual well state.

In the District Court, Defendant-Appellee introduced a hypothetical, drilling engineer, Tom, in an attempt to show that the '812 Patent is an unpatentable mental process. But, as discussed above, a hypothetical driller engineer relying solely on his instruments and personal observations would only produce the conditions giving rise to the '812 Patent's invention in the first place. i.e. he would only guess at the actual well state. That a hypothetical drilling engineer could, as taught by the '812 Patent, record data from the sensors at the required intervals, compile threshold state data for verification and compare this to a plurality of memorized well state data is inconsequential if he cannot make a real-time state selection. Simply put, automated recognitions technology provides no tangible benefit in this context unless it can synthesize numerous sources of hydraulic and mechanical data from multiple systems on a rig at or near real-time speed. For this reason, "[p]encil-and-paper analysis can mislead courts into ignoring a key fact:

although a computer performs the same math as a human, a human cannot always achieve the same results as a computer." *Id.* at 995.

The Court should therefore find that an inventive concept lies within the '812 Patent's claims because it yields a new and useful method to determine well states in real time that did not exist before and cannot be replicated by the human mind.

b. The '812 Patent's Asserted Claims Contain an Inventive Concept Because They Contain Meaningful Limitations on the Scope of the Invention that Disclose Specific Structures in Particular Embodiments

The '812 Patent's claims contain meaningful limitations which restrict the scope of the invention to certain parameters and data metrics disclosed in the specifications. As such, Plaintiff does not seek to monopolize all "well state detection," but rather its particular systems and methods of well state detection. The claimed invention recites four specific machines to accomplish the method in claim 1: (i) a machine for storing a plurality of states, (ii) a machine for receiving mechanical and hydraulic data, (iii) a machine for determining that at least some of the data is valid, and (iv) a machine for automatically selecting the state of the well operation. Particular embodiments require "programmed hardware such as application-specific integrated circuits (ASIC), field programmable gate arrays (FPGA), digital signal processors (DSP) and the like." '812 Patent, col. 6 ln. 9-16,

cl. 31. These are not general processors, but rather hardware specifically tailored to implement the ‘812 Patent’s claimed method.

The ‘812 Patent’s claims rely on the specific machines indicated above. Moreover, the novelty of the ‘812 Patent’s method and system claims is that their unconventional combination of elements integrates directly into the solution provided. The claims thus impose meaningful limitations on the scope of the invention such that it only encompasses the particular embodiments disclosed by the claims and does not preempt the entire concept of automated well state detection. Finally, invalidating the ‘812 Patent entirely where certain disclosed embodiments contain the necessary inventive concept would be improper. *See* 35 U.S.C. § 112(6).[10]

In fact, Defendant-Appellee’s own invalidity references provide confirmation that the ‘812 Patent represented a significant technology improvement over the existing state of well state detection that existed when the patent application was filed on May 21, 2002. For example, U.S. Patent Nos. 4,825,962 and 4,875,530 were both cited by the Patent Examiner during prosecution as disclosing some process of well state determination. (A00505.)

[10] 35 U.S.C. §112(6): “An element in a claim for a combination may be expressed as a means or step for performing a specific function without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the corresponding structure, material or acts described in the specification and equivalents thereof.”

Further, SPE Paper No. 30523, listed in the International Search Report also discloses well state detection. (*See* A00545.) Clearly, the '812 Patent could have never issued in light of these references if it truly "preempted" the field of "well state detection."

Perhaps even more telling is that a patent on a "method for drilling while automatically detecting the state of a drilling rig during the drilling process of a wellbore" issued after the '812 Patent. (*See* U.S. Patent No. 7,128,167) (A01323-A01348.) This patent, titled "System and Method of Rig State Detection," is yet another example of a well state detection system that was not preempted by the '812 Patent. Indeed, the U.S. Patent Examiner considered the '167 patent application in light of the '812 patent-in-suit and determined that the '167 patent should issue. (A01323.) Clearly, if the '812 Patent had "preempted" the fundamental building block of "well state detection," the '167 patent could never have issued.

3. The '812 Patent Is Further Patent-Eligible Because of the Claims' Necessarily Close Connection to a Specific Device – the Individual Components Comprising an Oil Rig

The '812 Patent's close connection to a specific machine, an oil rig, strongly supports a finding that it is patent-eligible. *See Fairfield Indus.*, 2014 WL 7342525, at *6. This stems from this Court's machine or transformation test, which provides a "'useful and important clue' for determining patent eligibility."

DDR Holdings, 773 F.3d at 1255 (quoting *Bilski v. Kappos*, 561 U.S. 593 (2010)). This test considers whether the invention: "(1) . . . is tied to a particular machine or apparatus, or (2) it transforms a particular article into a different state or thing." *SiRF Technology, Inc. v. International Trade Com'n*, 601 F.3d 1319, 1332 (Fed. Cir. 2010). Additionally, the "the use of a specific machine or transformation of an article must impose meaningful limits on the claim's scope." *Id.* Thus, use of a specific device that is "integral" to the claimed method satisfies this test. *See Fairfield Indus.*, 2014 WL 7342525, at *6-7 (finding patent eligibility where method required use of seismic acquisition units).

Here, a well operation and its integrated sensors are essential to practicing the asserted claims of the '812 Patent.[11] Specifically, each asserted claim requires receiving "mechanical and hydraulic data reported for the well operation." (*See* '812 Patent col. 1) (A00041.) As discussed above, the data received is representative of physical parameters of oil well machinery, such as the pumps or the Kelley. Other examples of physical parameters are measured depth (claims 23, 25 and 53), RPM of the drill string (claim 32, 33 and 34), Stand Pipe Pressure (claim 54), hook load (claim 92) and bit position (claims 85 and 93) (See '812

[11] To the extent that any of the asserted claims in the '812 Patent do not explicitly require use of a well operation, Plaintiff-Appellant respectfully requests that the Court so presume for purposes of de novo review of a Rule 12(b)(6) ruling. *See Content Guard*, 776 F.3d at 1358 n.1.

patent, Col. 6/lines 25-29.) Each of these parameters represents the physical condition of the oil rig. These physical parameters are filtered and validated to determine the state of the well operation, i.e. the specific action taking place in the well operation. Put differently, the invention is integrated into the rig to determine whether it is performing actions, such as drilling (claim 2), reaming, sliding (claim 5), tripping pipe in hole (claim 14) or tripping pipe out of hole (claim 20). And as discussed above, the operation of the rig can further be controlled based on "evaluation of the parameters." (*See* '812 patent, claims 30, 60 and 90).

The '812 Patent was invented to solve this technological gap in the drilling industry by implementing a solution that harnesses mechanical and hydraulic data inputs from sensors on the well operation itself to yield a new and useful result and, as discussed below, to remove the "guesswork" and uncertainty when the well state is determined. As the specifications and figures confirm, the method claimed by the '812 Patent demands complete integration into a physical well operation. As such, the '812 Patent claims a tangible method, apparatus and system for accomplishing this result.

4. The Data Validation Step Recited in the '812 Patent Represents Only One of Virtually Limitless Possible Data Validation Models and Is Therefore Not Unduly Preemptive

In relevant part, the '812 Patent claims "determining that at least some of the data is valid by comparing the at least some of the data to at least one limit."

According to Defendant-Appellee Moblize, this is not a meaningful limitation because it does not ensure the claims do not preempt the field for well state detection. But Defendant-Appellee's own references prove this is incorrect. Specifically, the following references produced by Defendant-Appellee Moblize disclose 36 methods of validating data that are not "comparing against a limit":

- IADC/SPE 19919:"Practical Application of Real-Time Expert System for Automatic Well Control discloses use of "median weighted average" to confirm data validity (A00784-A00795);
- SPE 13019 "Design and Impact of a Real-Time Drilling Data Center" discloses "sensor maintenance" and "sensor calibration" as a method of data validation (A00776-A00783);
- AADE-091-NO-HO-38, "Data Processing and Interpretation While Drilling," discloses "data smoothing" and use of "Kalman filtering" to validate data (A00796-A00809);
- U.S. Patent No. 4,610,161, "Method and Apparatus for Improving Drilling Depth Measurement," discloses data averaging to validate data (A00832-A00841);
- SPE20107, "Field Experiences with Computer Controlled Drilling," discloses the use of "hardened sensors" and use of "redundant sensors" to ensure data validity (A00919-A0934);

- Carpenter J., "Building Robust Simulation Based Filters for Evolving Data Sets," discloses "Bayesian Filtering," use of "Extended Kalman Filters," use of Gaussian Sum Filters, Sampling Importance Resampling (SIR) algorithms , pseudo-bayesian algorithms, and removing 40 greatest outliers [of data]" to validate data (A00935-A00961);
- GasTips, February 2000, "Intelligent Drilling Monitor Detects Downhole Problems," Harmse J. et al. discloses a number of numerical techniques, including "sequential statistical tests to validate data, Bayesian network causal models" to detect "parameter sensor errors," and comparing sensors that measure the same property against one another to validate data (A00973-A00980);
- SPE 25319, "Factors Limiting the Quantitative Use of Mud Logging Data," discloses "documentation of [sensor] accuracy through traceable calibration certificates" to validate data (A00998-A01004);
- SPE 56634, "A Probabilistic Reasoning Tool for Circulation Monitoring Based on Flow Measurements," discloses CuSum (Cumulative Sum Testing) and use of "data fusion" to confirm data reliability by comparing "the relationship between data," by

comparing data streams against other data streams to see if they are consistent (A01005-A01008);

- Oil & Gas Journal, February 24, 1992, "Computerized Flow Monitors Detect Small Kicks," discloses "automatically calibrating sensors" and using "trend analysis" to determine problems with data or sensors to validate data (A01019-A01022);
- SPE 22571, "Improved Drilling Performance, Efficiency, and Operations Using an Advanced Real-Time Information System for Drilling," Once, Y. et al., SPE 66th Annual Conference discloses human review of data and "manual entry of bad or missing data" to ensure data validity (A01035-A01044);
- U.S. Patent No. 5,654,503, "Method and Apparatus for Improving Measurement of Drilling Conditions," discloses using surface parameters to estimate downhole conditions using a "predictive equation" to determine if the data from the downhole sensors is accurate by comparing it against the predicted value (A01212-A01224);
- U.S. Patent No. 5,699,246, "Method to Estimate a Corrected Response of a Measurement Apparatus Relative to a Set of Known Responses and Observed Measurements," discloses use of weighted

multiple linear regression to accurately determine physical properties, i.e. data validation (A01225-A01241);

- U.S. Patent No. 5,952,569, “Alarm System for Wellbore Site,” discloses measured signals compared to a number of possible signals and the probability of said measured signals representing an event are calculated to ensure data validity (A01242-A01249);
- U.S. Patent No. 6,276,465, “Method and Apparatus for Determining Potential for Drill Bit Performance,” discloses use of fuzzy logic and an interference engine computer adapted to utilize a plurality of wellbore parameters to ensure data validity (A01264-A01290);
- U.S. Patent No. 6,490,527, “Method of Characterization of Rock Strata for Drilling Operations,” discloses use of neural networks to validate data (A01300-A01311);
- U.S. Patent No. 6,662,110, “Drilling Rig Closed Loop Controls,” discloses comparison of surface sensor data to downhole data to confirm data accuracy (A01312-A01322);
- U.S. Patent No. 7,128,167, “System and Method for Rig State Detection,” discloses parametric filtering in conjunction with rig state detection to validate data (A01323-A01348);

- Morris, Alan S., "Measurement & Instrumentation Principles," discloses "careful instrument design" as a method of validating sensor data; methods of designing instruments/sensors with opposing inputs to validate data; high-gain feed back instruments/sensors to improve data validity/accuracy; manual correction of output readings from instrument/sensors; maintaining good calibration records for sensors to improve data quality/validity; and frequent maintenance and replacement of worn sensor parts to improve data quality/validity of sensors (A01349-A01394).

The '812 Patent-in-Suit also discloses that the filtering and validation step may occur via the use of filtering algorithms such as Butterworth, Chebyshev type I, Chebyshev type II, Elliptic, Equiripple, least squares, Bartlett, Blackman, Boxcar, Chebyshev, Hamming, Hann, Kaiser, FFT, Savitzky Golay, Detrend, Cumsum, or other suitable data filtering algorithms. ('812 Patent, Col 8, ln 51-56) (A00044.) Thus, these algorithms could also be used to validate/filter sensor data.

The above references reiterate that the '812 Patent does not preempt the entire abstract concept of "well state determination" and that numerous different ways exist to validate data. Clearly, a patent limited to one method of many is neither unduly preemptive of the field of use nor impermissibly broad.

Because claim construction has not occurred in this case, it remains to be seen which of the 36 data validation methods are equivalent to data validation by "determining that at least some of the data is valid by comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data," as is required by '812 patent's claims. (*See* Claims 1-115). Thus, the '812 patent potentially claims only a small fraction of the potential methods and systems for determining well states. It does not "monopolize" all forms of well state detection and is therefore "significantly more" than just the abstract idea of well state detection.

C. Defendant's Assertion that the Steps of the '812 Patent Are Conventional or Well Understood in the Industry Is Unsupported, and thus Dismissal Was Inappropriate

As discussed above, references produced by Defendant-Appellee and cited as "invalidating" of the '812 patent disclose that data validation by "comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data" is undesirable because of "frequent false alarms caused by testing against a threshold." *See* Jardine, et al., "An Improved Kick Detection System for Floating

Rigs," SPE 22133 (A00246-A00253) ("*Additional features of the flow monitoring system include automatic switch-off of the alarm system during periods of transient flow or rapid string movement. This prevents false alarms occurring when flow is unstable, for example at connections*.") (emphasis added). Other references produced by Defendant-Appellee Moblize also disclose that validation by comparison against a "threshold" can produce problems. *See* Hargreaves, et al., "Early Kick Detection for Deepwater Drilling: New Probabilistic Methods Applied in the Field," SPE 71369 (2001) (A000291-A00300.) For this reason, the Record is, at best, unclear if the data validation element of the claims of the '812 patent is "conventional" or "known." Thus, before claim construction, dismissal is inappropriate.

D. The References Cited During the Prosecution of the '812 Patent Confirm that the Claims are "Significantly More" Than the Abstract Idea of "Well State Detection"

Finally, the '812 Patent's prosecution history confirms that its claims are an "inventive concept" that is "significantly more" than the abstract idea of "well state determination." The patentee overcame a rejection in light of no fewer than three references the Examiner asserted also disclosed well state detection. The claims thus are distinguishable from other previously known methods for determining the state of the well. The '812 Patent therefore contains an "inventive concept" and is not unduly preemptive.

III. Conclusion

The ‘812 Patent is not abstract, and the Supreme Court’s decision in *Alice Corp. v. CLS Bank Int’l,* 134 S.Ct. 2347 (2014) confirms that it claims tangible subject matter that discloses an “inventive concept” which is “significantly more” than the idea of “well state determination.” Plaintiff-Appellant TDE accordingly requests that this Court reverse the District Court’s ruling and hold that the ‘812 Patent is directed to statutory subject matter.

Respectfully submitted:

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November 30, 2015

ADDENDUM

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TAB 1

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION

TDE PETROLEUM DATA SOLUTIONS, INC.,	§	
	§	
Plaintiff,	§	
	§	
v.	§	CIVIL ACTION H-15-1821
	§	
AKM ENTERPRISE, INC.,	§	
	§	
Defendant.	§	

FINAL JUDGMENT

Pursuant to the memorandum opinion and order filed this day, defendant AKM Enterprise's motion to dismiss is GRANTED. TDE's claims are DISMISSED WITH PREJUDICE, and JUDGMENT shall enter in defendant AKM Enterprise, Inc.'s favor.

This is a FINAL JUDGMENT.

Signed at Houston, Texas on September 11, 2015.

Gray H. Miller
United States District Judge

TAB 2

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF TEXAS
HOUSTON DIVISION

TDE PETROLEUM DATA SOLUTIONS, INC.,	§	
	§	
Plaintiff,	§	
	§	
v.	§	CIVIL ACTION H-15-1821
	§	
AKM ENTERPRISE, INC.,	§	
	§	
Defendant.	§	

MEMORANDUM OPINION AND ORDER

Pending before the court is a motion to dismiss pursuant to Federal Rule of Civil Procedure 12(b)(6) filed by defendant AKM Enterprise, Inc., d/b/a Moblize, Inc. ("Moblize"). Dkt. 24. Having considered the motion, response, reply, and applicable law, the court is of the opinion that the motion should be GRANTED.

I. BACKGROUND

Plaintiff TDE Petroleum Data Solutions, Inc. ("TDE") is the owner of all rights, title, and interests in United States Patent No. 6,892,812 (the "'812 Patent"), titled "Automated Method and System for Determining the State of Well Operations and Performing Process Evaluation" (the "Patented System"). Dkt. 1. The Abstract of the '812 Patent states:

> An automated method and system for determining the state of a drilling or other suitable well operations includes storing a plurality of states for the well operation. Mechanical and hydraulic data is received for the well operation. Based on the mechanical and hydraulic data, one of the states is automatically selected as the state of the well operation. Process evaluation may be performed based on the state of the well operation.

Dkt. 1, Ex. 1 (the '812 Patent). TDE provides services that allow rig operators to monitor and organize global rig operations. Dkt. 1. To provide these services, TDE uses technology developed

by Noble Drilling Services, which is the company that originally developed the '812 Patent. TDE began offering services using the '812 Patent's methods in 2009. *Id.*

TDE discovered that Moblize entered the marketplace some time before October 2014 and that Moblize offered a service that TDE contends infringes one or more claims of the '812 Patent. *Id.* Moblize offers a service that aggregates data from the field source to provide real time analytics on well optimization and "smart rig state" detection. *Id.* TDE met with Moblize's president to discuss the '812 patent on or about January 21, 2015. *Id.* TDE contends that Moblize continued to sell its infringing services after that meeting, which TDE asserts constitutes a knowing violation of U.S. patent law. *Id.*

TDE filed this lawsuit on May 4, 2015. *Id.* TDE contends that Moblize has infringed the '812 Patent by offering its automated determination of well states services in violation of 35 U.S.C. § 271. *Id.* TDE asserts that it is entitled to increased damages and attorneys' fees under 35 U.S.C. §§ 284 and 285 because Moblize's actions were willful and in deliberate disregard of TDE's rights. *Id.* TDE additionally claims that Moblize engaged in contributory infringement by providing data obtained using the Patented System to Moblize's customers for their use. *Id.* TDE contends that it has been irreparably harmed by Moblize's actions and will continue to be harmed unless Moblize is permanently enjoined from infringing the '812 Patent. *Id.*

Moblize now moves to dismiss the lawsuit, claiming that the Patented System is a patent-ineligible abstract idea under *Alice Corp. v. CLS Bank International*, 134 S. Ct. 2347 (2014). Dkt. 24. It contends that the claims of the '812 Patent are directed to the age-old concept of applying mathematical rules to interpret data, which is an abstract idea, and that the steps of the '812 Patent contain no inventive concepts that would transform the abstract idea into a patent-eligible application. *Id.* TDE argues, conversely, that the '812 Patent discloses a novel method that did not

previously exist in the energy sector and that its claims build and improve upon existing technological processes. Dkt. 30.

II. LEGAL STANDARD

Rule 8(a)(2) requires that the pleading contain "a short and plain statement of the claim showing that the pleader is entitled to relief." Fed. R. Civ. P. 8(a)(2). In turn, a party against whom claims are asserted may move to dismiss those claims when the pleader has failed "to state a claim upon which relief can be granted." Fed. R. Civ. P. 12(b)(6). To survive a Rule 12(b)(6) motion, a pleading must offer "'enough facts to state a claim to relief that is plausible on its face.'" *In re Katrina Canal Breaches Litig.*, 495 F.3d 191, 205 (5th Cir. 2007) (quoting *Bell Atl. Corp. v. Twombly*, 550 U.S. 544, 570, 127 S. Ct. 1955 (2007)). "Factual allegations must be enough to raise a right to relief above the speculative level, . . . on the assumption that all the allegations in the complaint are true (even if doubtful in fact) . . . ." *Twombly*, 550 U.S. at 555 (citations omitted). While the allegations need not be overly detailed, a plaintiff's pleading must still provide the grounds of his entitlement to relief, which "requires more than labels and conclusions," and "a formulaic recitation of the elements of a cause of action will not do." *Id.*; *see also Ashcroft v. Iqbal*, 556 U.S. 662, 678, 129 S. Ct. 1937 (2009) ("[N]aked assertions devoid of further factual enhancement," along with "legal conclusions" are not entitled to the presumption of truth). "[C]onclusory allegations or legal conclusions masquerading as factual conclusions will not suffice to prevent a motion to dismiss." *Fernandez-Montes v. Allied Pilots Ass'n*, 987 F.2d 278, 284 (5th Cir. 1993). Instead, "[a] claim has facial plausibility when the plaintiff pleads factual content that allows the court to draw the reasonable inference that the defendant is liable for the misconduct alleged." *Iqbal*, 556 U.S. at 678. Evaluating a motion to dismiss is a "context-specific task that requires the reviewing court to draw on its judicial experience and common sense." *Id.* at 679.

III. Analysis

Under 35 U.S.C. § 101, "[w]hoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of title." While Congress "'contemplated that patent laws would be given a wide scope,'" the United States Supreme Court has provided for three exceptions to section 101's patent-eligibility principles. *Bilski v. Kappos*, 561 U.S. 593, 602, 130 S. Ct. 3218 (2010) (quoting *Diamond v. Chakrabarty*, 447 U.S. 303, 308, 100 S. Ct. 2204 (1980)). These exceptions are "laws of nature, physical phenomena, and abstract ideas." *Chakrabarty*, 447 U.S. at 309. Of course, courts should be mindful that "[a]t some level, 'all inventions . . . embody, use, reflect, rest upon, or apply law of nature, natural phenomena, or abstract ideas.'" *Alice Corp.*, 134 S. Ct. at 2354 (quoting *Mayo Collaborative Servs. v. Prometheus Labs., Inc.*, 566 U.S. __, 132 S. Ct. 1289, 1293 (2012)).

An invention is not patent-ineligible simply because it involves an abstract concept. Instead, if the abstract concept is applied to "a new and useful end," it remains eligible for patent protection. *Id.* (citing *Gottschalk v. Benson*, 409 U.S. 63, 67, 93 S. Ct. 253 (1972)). To differentiate, courts must first "determine whether the claims at issue are directed to one of those patent-ineligible concepts." *Alice Corp.*, 134 S. Ct. at 2355. If so, courts next ask if the elements of the claim contain an "inventive concept" that "transforms" the abstract idea into a patent-eligible application. *Id.* at 2357. To answer this question, court must "consider the elements of each claim both individually and 'as an ordered combination.'" *Id.* at 2355 (quoting *Mayo Collaborative Servs.*, 132 S. Ct. at 1297–98). "A claim that recites an abstract idea must include 'additional features' to ensure 'that the [claim] is more than a drafting effort designed to monopolize the [abstract idea].'" *Id.* at 2357 (quoting *Mayo Collaborative Servs.*, 132 S. Ct. at 1297).

A. *Alice Corp.* Step One

The court thus first asks, are the claims in the ‘812 Patent directed to an abstract concept? TDE argues that the ‘812 Patent is directed to a tangible, new technical solution to a problem unique to the energy sector. Dkt. 30 at 9. It asserts that “[a]t their core, the ‘812 Patent’s claims recite methods for automated well state detection, which include the necessary steps of: (1) storing well states; (2) receiving mechanical and hydraulic data from sensors in the well operation; (3) verifying the data against thresholds that in some embodiments require use of application-specific programmed hardware; and (4) selecting a well state.” *Id.*

Moblize argues, on the other hand, that Claim 1 “involves nothing more than the basic steps of (1) making a list of possible values (drilling ‘states’), (2) receiving data about those values, (3) applying mathematical rules to the data (by comparing data to the ‘limit’)[,] and (4) interpreting the results to choose a value from the list.” Dkt. 24. Moblize contends that “[a]t their core, these steps state the fundamental concept of interpreting data by applying mathematical rules.” *Id.* It asserts that TDE’s claimed method falls squarely within the type of data-interpretation claims that the Federal Circuit and district courts have held are abstract. *Id.*

Moblize mainly relies on the following cases to support its argument that TDE’s claims recite an abstract idea: *Alice Corp.*; *Planet Bingo, LLC v. VKGS LLC*, 576 F. App’x 1005, 1007 (Fed. Cir. 2014); and *Digitech Image Technologies, LLC v. Electronics for Imaging, Inc.*, 758 F.3d 1344, 1351 (Fed. Cir. 2014). In *Alice*, the U.S. Supreme Court reasoned that the claims at issue were “drawn to the concept of intermediated settlement,” which is a “fundamental economic practice long prevalent in our economic system.” *Alice*, 134 S. Ct. at 2356. The Court held that intermediated settlement was an abstract idea beyond the scope of section 101. *Id.*

In *Digitech Image Technologies, LLC*, 758 F.3d at 1351, the Federal Circuit considered whether a process for generating a device profile tied to a digital image processing system was an abstract idea that could not be patented. It held that the method in the patent was an abstract idea "because it describes a process of organizing information through mathematical correlations and is not tied to a specific structure or machine." *Digitech Image Techs.*, 758 F.3d at 1350. It noted that claim 10 of the patent at issue recited a process of taking two data sets and combining them into one meaningful data set. *Id.* at 1351. The data sets were generated by taking existing information and organizing it into a new form. *Id.* The court explained that "[w]ithout additional limitations, a process that employs mathematical algorithms to manipulate existing information to generate additional information is not patent eligible." *Id.*

In *Planet Bingo*, the Federal Circuit considered whether two patents relating to methods and systems for managing the game of bingo claimed patentable subject matter under *Alice Corp.* and section 101. 576 F. App'x at 1006. Planet Bingo owned the patents, and it filed an infringement claim against VKGS LLC d/b/a Video King ("Video King"). *Id.* The district court granted summary judgment in favor of Video King, finding that the each method claim encompassed the abstract idea of managing a bingo game and, though the claims employed a computer to store numbers, assign identifiers, and other miscellaneous things, the computer added "'nothing more than the ability to manage . . . Bingo more efficiently.'" *Id.* at 1007. Planet Bingo argued that the computers used for the method handled so many numbers ("thousands, if not millions") that it would be impossible to carry out the method manually. *Id.* at 1008. The court, however, observed that the claims as written actually required, at most, two sets of numbers, a player, and a manager. *Id.* The court declined to address whether an invention that handled thousands or millions of numbers, as Planet Bingo argued, would be eligible for a patent. *Id.*

TDE primarily relies on *Wavetronix LLC v. Iteris, Inc.*, No. A-14-CA-970-SS, 2015 WL 300726 (W.D. Tex. Jan. 22, 2015), for its argument that the '812 Patent's methods and systems for automated well state detection are not abstract. *See* Dkt. 30 at 10–12. In *Wavetronix*, the federal district court for the Western District of Texas considered plaintiff Wavetronix, LLC's motion for a preliminary injunction. 2015 WL 300726, at *1. Wavetronix owns a patent covering its SmartSensor Advance invention, which uses radar to track the speed and location of vehicles at an intersection, uses the data to calculate an estimated time of arrival at the intersection, and determines if the vehicle will arrive at the intersection within the "dilemma zone," a zone in which a driver faces the dilemma of either hitting the brakes to stop in time for the red light, or stepping on the gas to make it through the light in time. *Id.* The invention advises the traffic controller that the light "ought to remain green rather than turn yellow" if vehicles will be in the dilemma zone. *Id.*

The *Wavetronix* court addressed whether the patent was directed to an abstract idea in its analysis of the likelihood of success prong of the preliminary injunction standard. *Id.* at *6. The defendant, relying on *Alice Corp.*, argued that a "'human with no more than a high-school level education can readily accomplish each of the steps taught [by the patent at issue] with nothing more than a paper and a pencil.'" *Id.* The court disagreed that *Alice Corp.* was applicable, finding that the patent at issue "improved upon existing technological processes for providing dilemma zone protection." *Id.* It appears that the court, rather than addressing whether the patent was directed to an abstract idea, determined that, regardless, Wavetronix improved upon existing technological processes by enabling "real-time tracking of vehicles as they approach an intersection." *Id.*

Here, TDE's arguments that the claims in the '812 Patent resemble those in the *Wavetronix* case and that the method is not abstract because it improves upon existing well operation recognition systems are more appropriately considered in the second step of the *Alice Corp.* analysis. The steps

that both Moblize and TDE contend are at the core of the '812 Patent are similar to those in *Planet Bingo* and *Digitech*. They are simple steps of storing data, receiving data, and using mathematics or a computer to organize that data and generate additional information. This is an abstract concept and not patent-eligible unless there is an "inventive concept" that "transforms" the abstract idea into a patent-eligible application.

B. *Alice Corp.* Step Two

TDE argues that the inventive concept behind the '812 Patent's claims stems from its combination of elements: (1) storing well states; (2) receiving mechanical and hydraulic data from sensors in the well operation; (3) verifying the data against thresholds that in some embodiments requires use of application-specific programmed hardware; and (4) automatically selecting a well state. Dkt. 30 at 14–15. TDE contends that these steps, taken together, yield a new and useful application to well state recognition. *Id.* at 15. TDE points out that the technological advantage over preexisting well operations management systems is the ability to determine well states in or near real time, which a human could not do. *Id.* TDE additionally argues that the '812 Patent's claims contain meaningful limitations that restrict the scope of the invention to certain parameters and data metrics disclosed in the specifications so that the patent owners are not monopolizing all well state detection. *Id.* It asserts that the claims embody an inventive concept that transforms the idea into a patent-eligible application because the claims require programmed hardware tailored to implement the method, not general processors. *Id.* at 16. Finally, TDE argues that the '812 Patent's close connection to a specific machine, the oil rig, supports a finding that it is patent-eligible. *Id.* at 17.

Moblize asserts that TDE ignores the actual claim language when making its arguments. Dkt. 46. Moblize argues that TDE "greatly overstates the complexity actually claimed." *Id.* Moblize notes that, for instance, Claim 1 requires only "a plurality" of states, "mechanical and

hydraulic data," and a comparison using basic math to determine the "state." *Id.* Moblize contends that TDE's focus on computerization is misplaced because using a computer to perform tasks more quickly is not sufficient to confer patent eligibility. *Id.* at 3 (citing *Intellectual Ventures I LLC v. Capital One Fin.*, No. 2014-1506, slip op. at 6 (Fed. Cir. July 6, 2015)).

Moblize asserts that TDE's argument about meaningful limitations related to use of machines is a red herring because the majority of the claims in the '812 Patent do not even include the word "machine" or any requirement that specific integrated circuits be used. *Id.* at 4. Additionally, Moblize points out that the question from *Alice Corp.* is *not* whether the patentee can point to some narrow embodiment that falls within the claims but whether the claims themselves *also* cover embodiments that are not narrowly limited. *Id.* Moblize contends that even the means-plus-function claims (i.e., Claim 31) are described as being implemented on a general purpose processor *or* with programmed hardware such as application-specific circuits. *Id.* at 4–5. Since the claims are broad enough to be implemented on a general purpose processor, they are not really limited at all. *Id.* at 5.

Moblize argues that TDE's argument that the claims are patent-eligible because of the connection to an oil rig is similarly flawed, as having a close connection to an oil rig does not transform the abstract claim into a patent-eligible application. *Id.* An oil rig itself is generic, and TDE's reference to integrated sensors in its argument cannot be linked to any language in the actual claims. *Id.* at 5–6. Moreover, Moblize argues that the claims do not recite any effect on the operation of an oil rig, so the alleged "close connection" to an oil rig is "illusory." *Id.*

1. Technological Advantage

In support of its argument that the '812 Patent discloses a technological advantage over preexisting well operations management systems, TDE cites *California Institute of Technology v.*

Hughes Communications, Inc., 59 F. Supp. 3d 974, 994 (C.D. Cal. 2014). In *California Institute of Technology*, the court looked at the specific limitations of patents relating to "a particular form of error correction code" or software. 59 F. Supp. 3d at 976. The court found that the claims were generally directed to abstract concepts, but that the asserted claims contained "meaningful limitations that represent sufficiently inventive concepts" and were thus patentable. *Id.* at 994. The court pointed out that even though many of the limitations were mathematical algorithms, they were narrowly defined and tied to a specific error correction process. *Id.* It found that the limitations were "not necessary or obvious tools for achieving error correction, and they ensure that the claims do not preempt the field of error correction." *Id.* The court specifically noted that while the calculations involved could be performed by a person with a pencil and paper, this analysis is not helpful for computer inventions as a pencil and paper can rarely produce the actual effect of the computer invention. *Id.* It pointed out that, with regard to software, "a human could spend months or years writing on paper the 1s and 0s comprising a computer program" and in the end he would just "be left with a lot of paper that obviously would not produce the same result as the software." *Id.*

The court finds the arguments in *California Institute of Technology* particularly compelling with regard to the invention discussed in that case. However, here the claims are not narrowly defined so as to ensure the claims do not preempt the field for well state detection. Instead, Claim 1, for instance, involves storing "a plurality of states for well operation," receiving well operation from "a plurality of systems," comparing the data to predefined limits, and selecting a state of well operation based on that comparison. Dkt. 1, Ex. 1. The only limit is that there must be more than one state, more than one system from which to receive data, and more than one state of well operation. Thus, there are essentially no limits—it covers practically any system for determining the state of well operation.

Moreover, unlike the software discussed in *California Institute of Technology*, it would not take months or years of writing on paper to replicate the method described in the '812 Patent, and recreating the method with a pencil and paper would have the same type of application as automating it on a computer. The only advantage of using the automated system is that, as TDE points out, real-time results are available. However, "[t]o salvage an otherwise patent-ineligible process, a computer must be integral to the claimed invention, facilitating the process in a way that a person making calculations or computations could not." *Bancorp Servs., L.L.C. v. Sun Life Assurance Co. of Can. (U.S.)*, 687 F.3d 1266, 1278 (Fed. Cir. 2012). "[S]imply appending generic computer functionality to lend speed or efficiency to the performance of an otherwise abstract concept does not meaningfully limit claim scope for purposes of patent eligibility." *CLS Bank Int'l v. Alice Corp. Pty. Ltd.*, 717 F.3d 1269, 1286 (Fed. Cir. 2013), *aff'd*, 134 S. Ct. 2347 (2014).[1]

2. Connection to Machines

TDE next argues that the claims are patent-eligible because they require programmed hardware tailored to implement the Patented System, not general processors, stating that the four steps of the Patented Method require specific machines to accomplish the steps. Dkt. 30 at 16. It points to the following language in the detailed description of the '812 Patent:

---

[1] Though TDE relied on the *Wavetronix* case for its argument that its claims are not abstract under the first *Alice Corp.* step and does not address it in its second-step analysis, the case is more on point for the second step. In *Wavetronix*, the court specifically found that the patent at issue in that case "improved upon existing technological processes" because it, unlike previous dilemma zone protection systems, actually solved a problem by improving on existing technology. 2015 WL 3000726, at *6. The previous systems had used methods other than radar, such as loops buried in the ground, to determine vehicles' arrival in the dilemma zone. *Id.* The patent at issue did not claim the unimproved applications, just the narrow application using radar. *Id.* Here, the claims as written, unlike the *Wavetronix* claims, do not add an inventive concept to existing technology. The only advantageous application highlighted by TDE is that the well state data can be monitored in real time, by using a generic computer or other machines. This is not enough of an innovation to make the claims patent-eligible.

> In a particular embodiment, the monitoring module and its various components and modules may comprise logic encoded in media. The logic may comprise software stored on a computer-readable medium for use in connection with a general purpose processor, or programmed hardware such as application-specific integrated circuits (ASIC), field programmable gate arrays (FPGA), digital signal processors (DSP) and the like.

'812 Patent, col. 6, ln. 9–16. While certainly this detailed description indicates that specific machines can be used to accomplish the steps, it also demonstrates that specific machines are not required and that a "general purpose processor" may be used. This argument does not support TDE's position that the abstract claims in the '812 Patent are meaningfully limited.

TDE also contends that the claims in the '812 Patent are patent-eligible because they are connected to an oil rig, citing *Fairfield Industries, Inc. v. Wireless Seismic, Inc.*, No. 4:14-cv-2972, 2014 WL 7342525 (S.D. Tex. Dec. 23, 2014) (Ellison, J.). Dkt. 30 at 17. In *Fairfield*, Judge Ellison denied a motion to dismiss an infringement case involving a patent for a method of seismic data acquisition relating to transmitting data from a seismic sensor array to a central control station. *Fairfield*, 2014 WL 7342525, at *1. Judge Ellison determined that the claims may have been directed to an abstract idea, but that, regardless, the claims easily satisfied the second step of the *Alice Corp.* test. *Id.* at *4. Specifically, the claims were for a "specific method of data transmission that is a new and useful application of a generic relay system" and that the claim built on the abstract concept of a relay system by adding nonconventional elements that narrowed the scope of the claim and minimized the risk of preemption. *Id.* at *6.

Judge Ellison determined that the claim's "close connection to a specific machine, the seismic acquisition unit, further support[ed] a finding of patent-eligibility," relying on the machine-or-transformation test. *Id.* Under this test, which provides a "useful important clue" for "determining whether some claimed inventions are processes under § 101," an invention is a process

if (1) it is tied to a particular machine or apparatus, or (2) it transforms an article into a different state or thing." *Bilski*, 561 U.S. at 602–03. Judge Ellison noted that for the connection of a machine to have any meaning in the analysis, its use must "impose meaningful limits on the claim's scope," "play a significant part in permitting the claimed method to be performed," and not "function solely as an obvious mechanism for permitting a solution to be achieved more quickly." *Fairfield*, 2014 WL 7342525, at *6 (citations and internal quotations marks omitted). Judge Ellison found that the use of the seismic acquisition units in the patent at issue in *Fairfield* passed these hurdles and that since the use of the units did "not merely substitute technology for an abstract idea, the connection between the claim and the acquisition units [was] highly probative of patent-eligibility." *Id.* at *7. The use of an oil rig in this case is completely different. While certainly the use of an oil rig is central to the claims, it does nothing to impose meaningful limits on the claim's scope.

C. Factual Disputes and Prematurity

TDE's final argument is that significant factual disputes pervade the analysis making a ruling on patent-eligibility at this stage premature. Dkt. 30 at 18. TDE concedes that patent eligibility is a question of law but points out that it "'may be informed by subsidiary factual issues.'" *Id.* (quoting *Accenture Glo. Servs., GmbH v. Guidewire Software, Inc.*, 728 F.3d 1336, 1341 (Fed. Cir. 2013)). TDE contends that there are several claim terms that raise substantial factual claim construction issues and that Moblize relied on unsupported factual assertions in its motion. *Id.* at 19. Moblize asserts that it made no "factual assertions," it merely used a hypothetical example. With regard to the claim construction issues, Moblize argues that they do not change the analysis. Dkt. 46 at 6–7.

First, the court did not rely on Moblize's hypothetical in reaching its conclusions, so there is no need to address that argument. With regard to the contention that the motion is premature, the court agrees with Moblize that TDE's claim construction contentions do not impact the analysis.

While undoubtedly there would be disputes about the meaning of certain terms if this case were to proceed to a *Markman* hearing, none of the terms that TDE contends will be in dispute prohibit the court from fully understanding the basic character of the claims. *See Content Extraction & Transmission LLC v. Wells Fargo Bank, N.A.*, 776 F.3d 1343, 1349 (Fed. Cir. 2014) ("[C]laim construction is not an inviolable prerequisite to a validity determination under § 101."); *Fairfield*, 2014 WL 7342525, at *4 ("[T]he court is satisfied that it has the full understanding of the basic character of the claimed subject matter required for an eligibility determination."). In *Content Extraction & Transmission*, the Federal Circuit affirmed a case in which the district court had granted a motion to dismiss prior to construing the claims. 776 F.3d at 1349. In considering the motion to dismiss, the district court had construed the terms in the manner most favorable to the patent owner and determined that the claims were patent-ineligible. *Id.* The Federal Circuit held, also construing the claims in the patent owner's favor, that "none of [the patent owner's] claims amount[ed] to 'significantly more' than [an] abstract idea." *Id.* Here, likewise, none of TDE's claims amount to significantly more than an abstract idea, even construing all the claims in TDE's favor.[2]

[2] TDE attempts to limit Claim 31's "means for" elements by providing guidance from the specification, but even the specification information highlighted by TDE indicates that the means "may" use certain machines or specific sub-modules. *See* Dkt. 30 at 19–21. There is no dispute that the patent *could* be tied to certain machines. Nothing in the patent, however, *requires* these specific components. The claims, as written, are not meaningfully limited, and TDE's construction still does not meaningfully limit them.

IV. CONCLUSION

The court finds that the claims in the '812 Patent are not patent-eligible. Accordingly, Moblize's motion to dismiss TDE's patent infringement lawsuit is GRANTED. TDE's claims are DISMISSED WITH PREJUDICE.

Signed at Houston, Texas on September 11, 2015.

Gray H. Miller
United States District Judge

TAB 3

US006892812B2

(12) **United States Patent**
Niedermayr et al.

(10) **Patent No.: US 6,892,812 B2**
(45) **Date of Patent: May 17, 2005**

(54) **AUTOMATED METHOD AND SYSTEM FOR DETERMINING THE STATE OF WELL OPERATIONS AND PERFORMING PROCESS EVALUATION**

(75) Inventors: **Michael Niedermayr**, Stafford, TX (US); **Mitchell D. Pinckard**, Houston, TX (US); **Gerhard P. Glaser**, Houston, TX (US)

(73) Assignee: **Noble Drilling Services Inc.**, Sugar Land, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/153,845**

(22) Filed: **May 21, 2002**

(65) **Prior Publication Data**

US 2003/0220742 A1 Nov. 27, 2003

(51) **Int. Cl.**[7] **E21B 44/00**

(52) **U.S. Cl.** **166/250.15**; 166/53; 175/24; 175/40; 702/9

(58) **Field of Search** 175/24–38, 40; 166/250.15, 53; 702/9; 340/854.1, 856.1, 856.3; 73/152.43, 152.19

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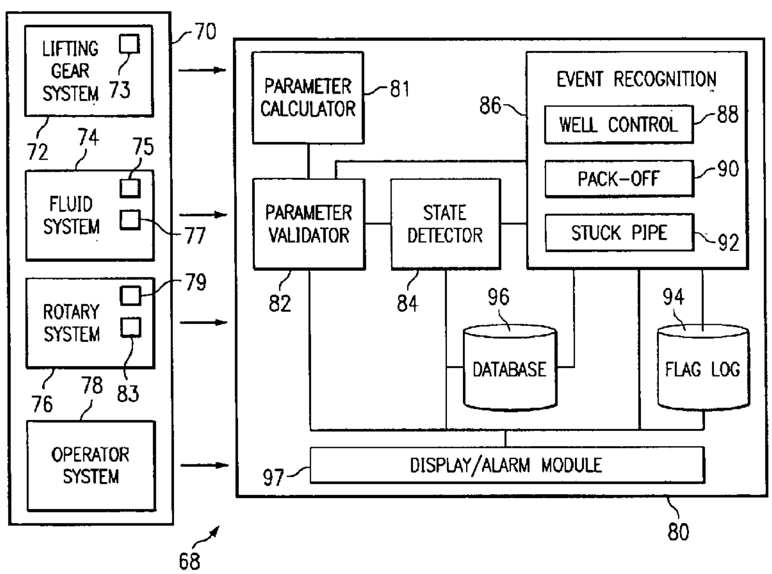
Primary Examiner—David Bagnell
Assistant Examiner—Matthew J. Smith
(74) *Attorney, Agent, or Firm*—Baker Botts L.L.P.

(57) **ABSTRACT**

An automated method and system for determining the state of a drilling or other suitable well operations includes storing a plurality of states for the well operation. Mechanical and hydraulic data is received for the well operation. Based on the mechanical and hydraulic data, one of the states is automatically selected as the state of the well operation. Process evaluation may be performed based on the state of the well operation.

115 Claims, 6 Drawing Sheets



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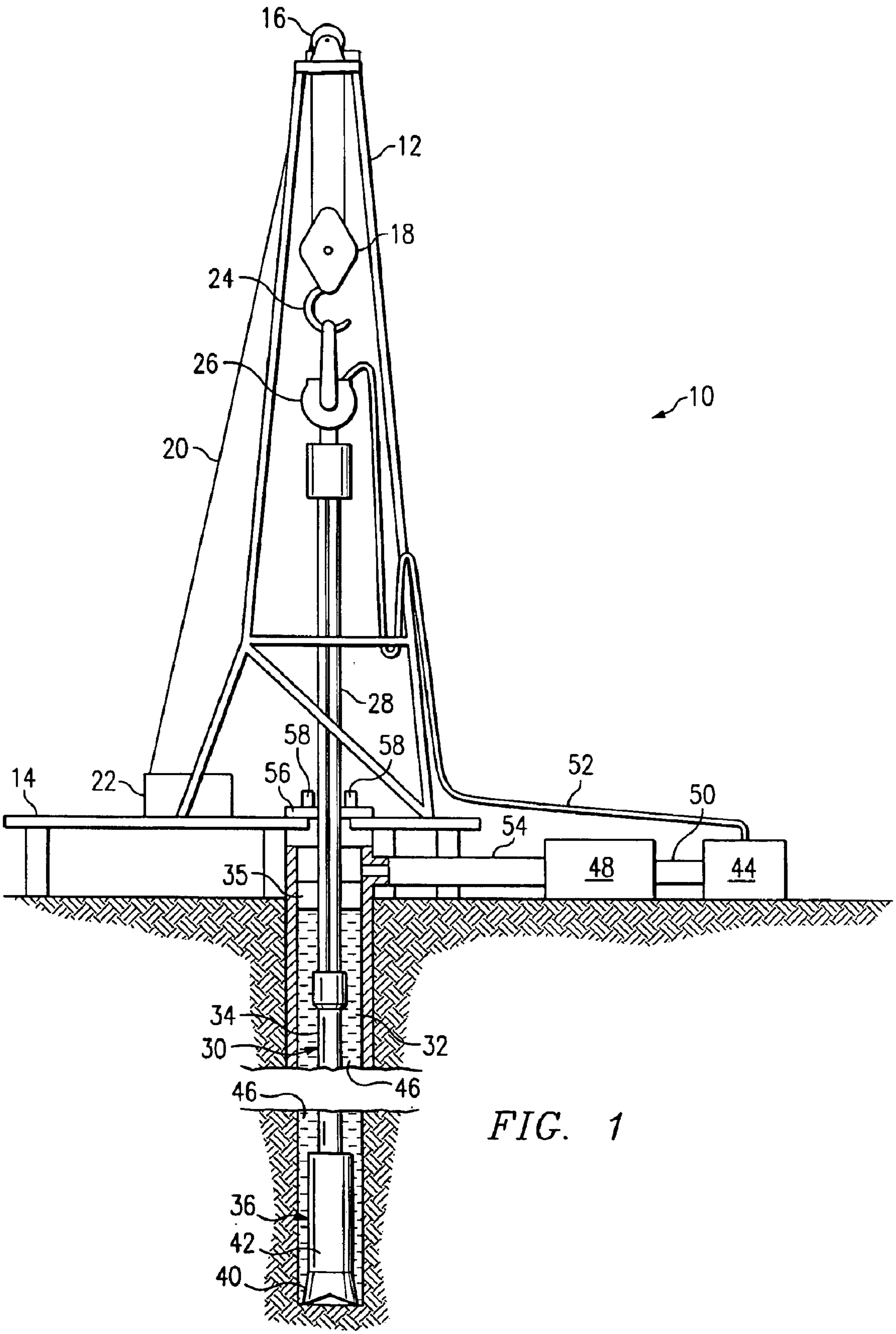
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12
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FIG. 1

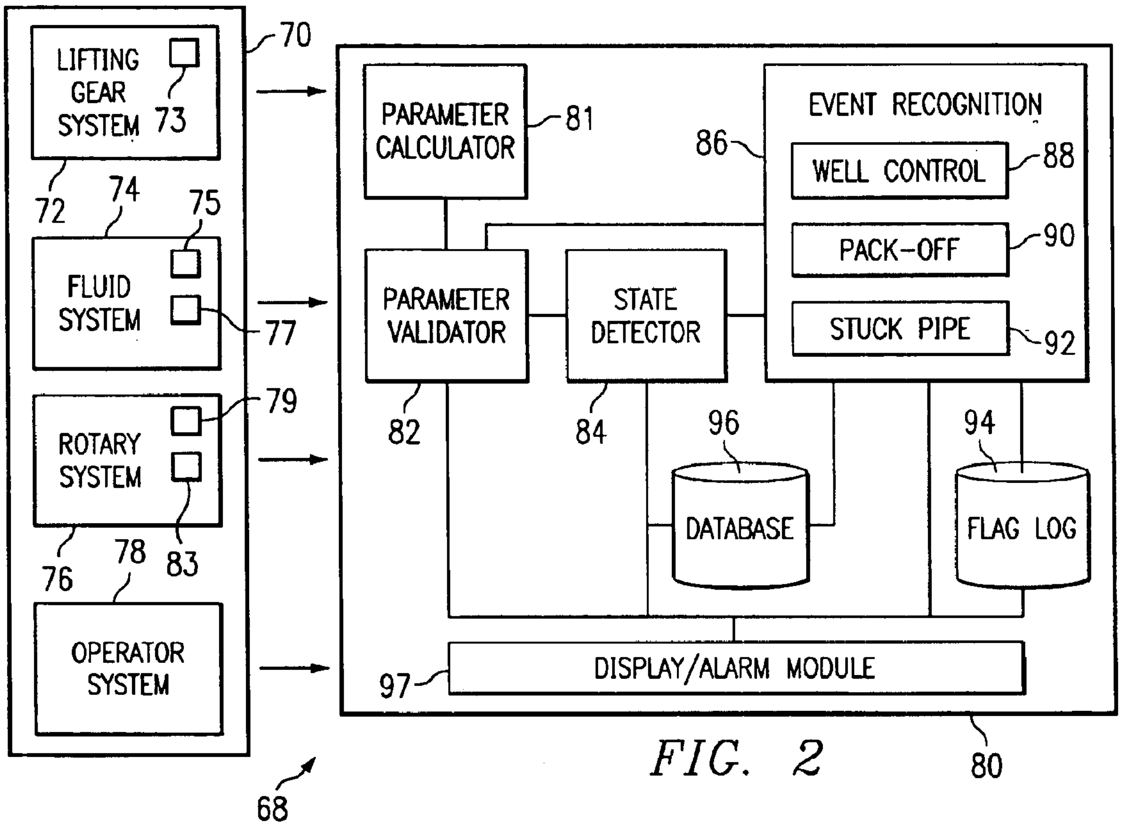

LIFTING GEAR SYSTEM
73
70
72
74
75
FLUID SYSTEM
77
79
ROTARY SYSTEM
76
78
83
OPERATOR SYSTEM
68
PARAMETER CALCULATOR
81
86
EVENT RECOGNITION
WELL CONTROL
88
PACK-OFF
90
STUCK PIPE
92
PARAMETER VALIDATOR
STATE DETECTOR
82
84
96
94
DATABASE
FLAG LOG
97
DISPLAY/ALARM MODULE
80

FIG. 2

FIG. 3

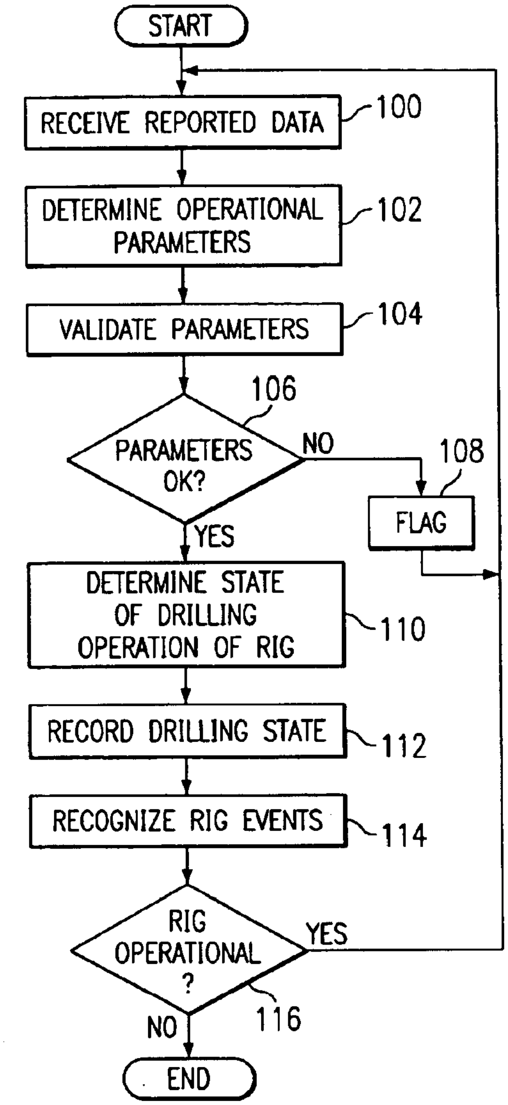

START
RECEIVE REPORTED DATA
100
DETERMINE OPERATIONAL PARAMETERS
102
VALIDATE PARAMETERS
104
106
PARAMETERS OK?
NO
108
FLAG
YES
DETERMINE STATE OF DRILLING OPERATION OF RIG
110
RECORD DRILLING STATE
112
RECOGNIZE RIG EVENTS
114
RIG OPERATIONAL ?
YES
NO
116
END

FIG. 4

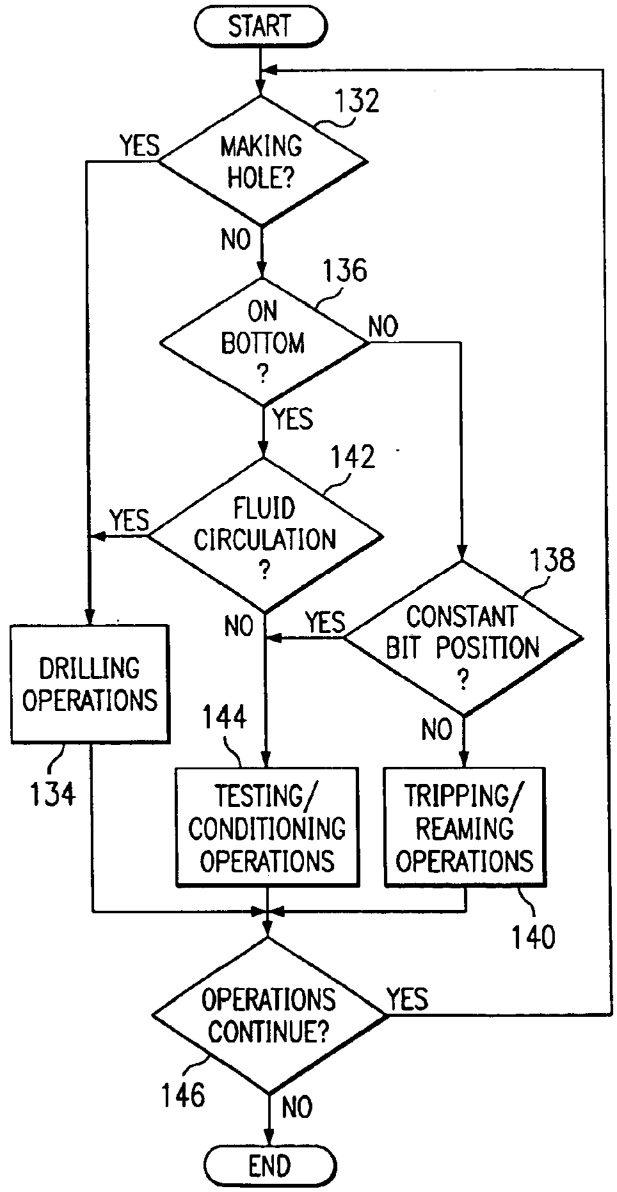

START
132
MAKING HOLE?
YES
NO
136
ON BOTTOM ?
NO
YES
142
FLUID CIRCULATION ?
YES
138
CONSTANT BIT POSITION ?
NO
YES
DRILLING OPERATIONS
134
144
TESTING/ CONDITIONING OPERATIONS
NO
TRIPPING/ REAMING OPERATIONS
140
OPERATIONS CONTINUE?
YES
146
NO
END

FIG. 5A

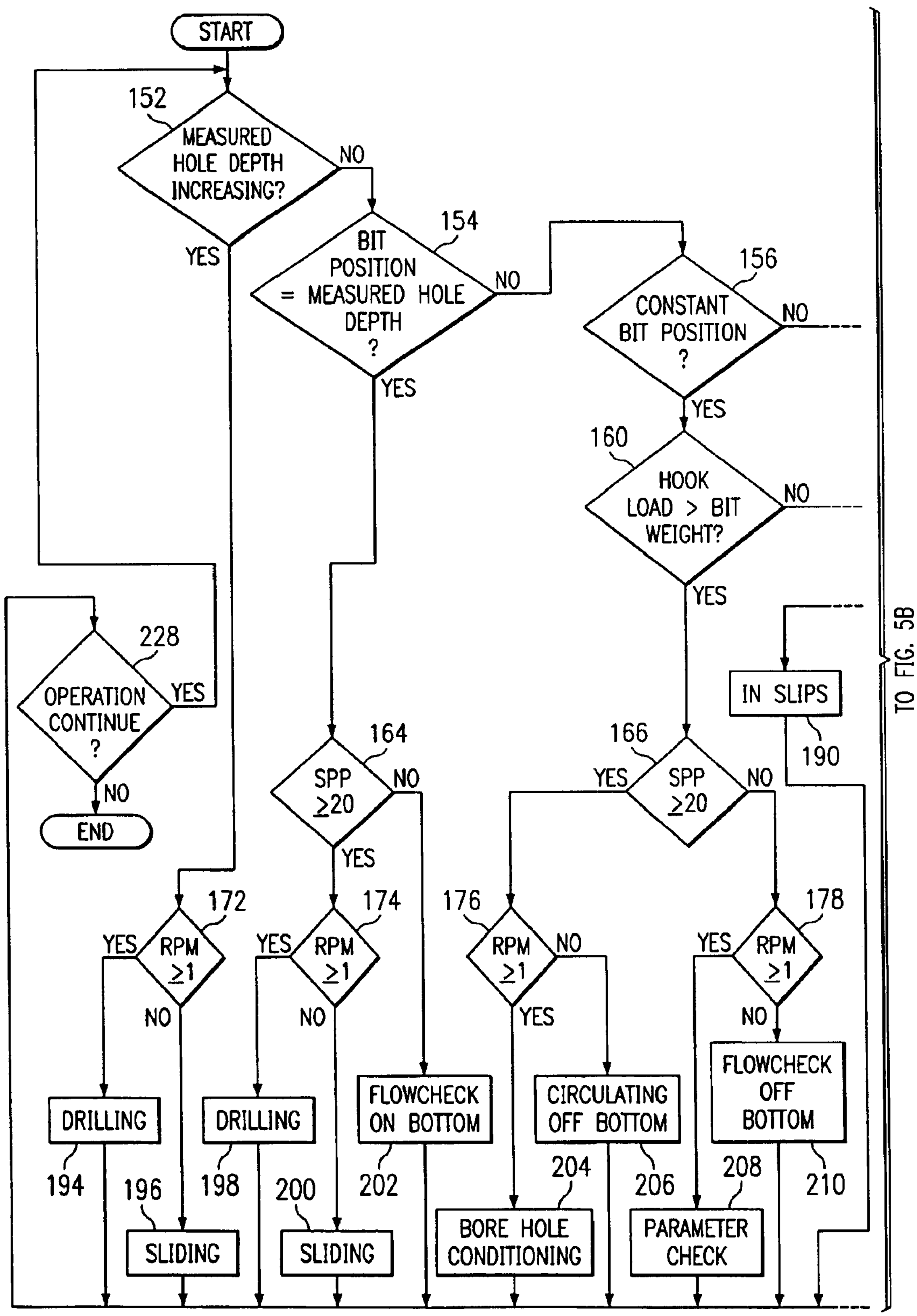
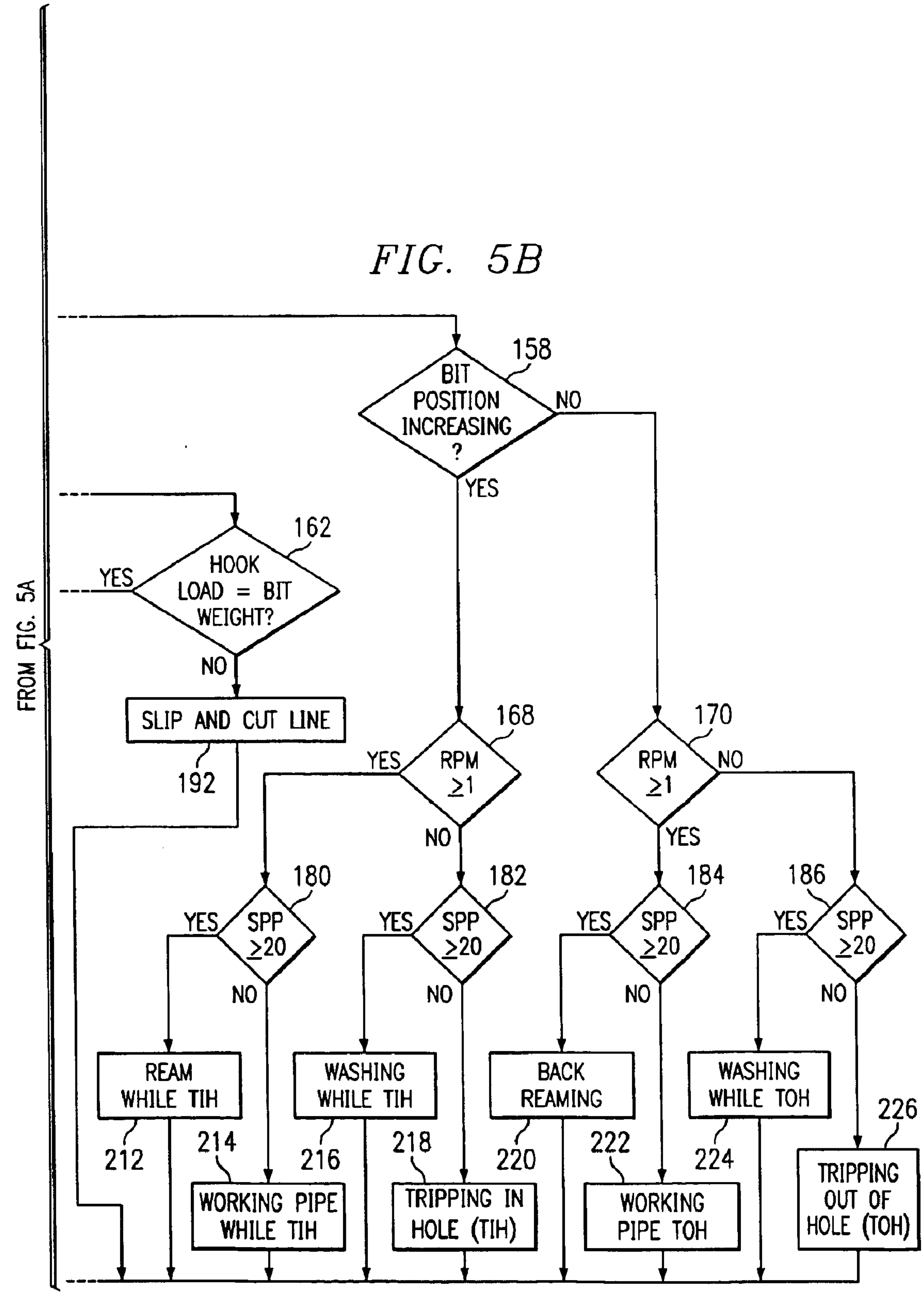

START
152
MEASURED HOLE DEPTH INCREASING?
NO
YES
154
BIT POSITION = MEASURED HOLE DEPTH ?
NO
YES
156
CONSTANT BIT POSITION ?
NO
YES
160
HOOK LOAD > BIT WEIGHT?
NO
YES
IN SLIPS
190
228
OPERATION CONTINUE ?
YES
NO
END
164
SPP ≥20
NO
YES
166
SPP ≥20
YES
NO
172
RPM ≥1
YES
NO
174
RPM ≥1
YES
NO
176
RPM ≥1
NO
YES
178
RPM ≥1
YES
NO
DRILLING
194
SLIDING
196
DRILLING
198
SLIDING
200
FLOWCHECK ON BOTTOM
202
BORE HOLE CONDITIONING
204
CIRCULATING OFF BOTTOM
206
PARAMETER CHECK
208
FLOWCHECK OFF BOTTOM
210
TO FIG. 5B

FIG. 5B


FROM FIG. 5A
158
BIT POSITION INCREASING ?
NO
YES
162
HOOK LOAD = BIT WEIGHT?
YES
NO
SLIP AND CUT LINE
192
168
RPM ≥1
YES
NO
170
RPM ≥1
NO
YES
180
SPP ≥20
182
SPP ≥20
184
SPP ≥20
186
SPP ≥20
YES
NO
REAM WHILE TIH
212
WORKING PIPE WHILE TIH
214
WASHING WHILE TIH
216
TRIPPING IN HOLE (TIH)
218
BACK REAMING
220
WORKING PIPE TOH
222
WASHING WHILE TOH
224
TRIPPING OUT OF HOLE (TOH)
226

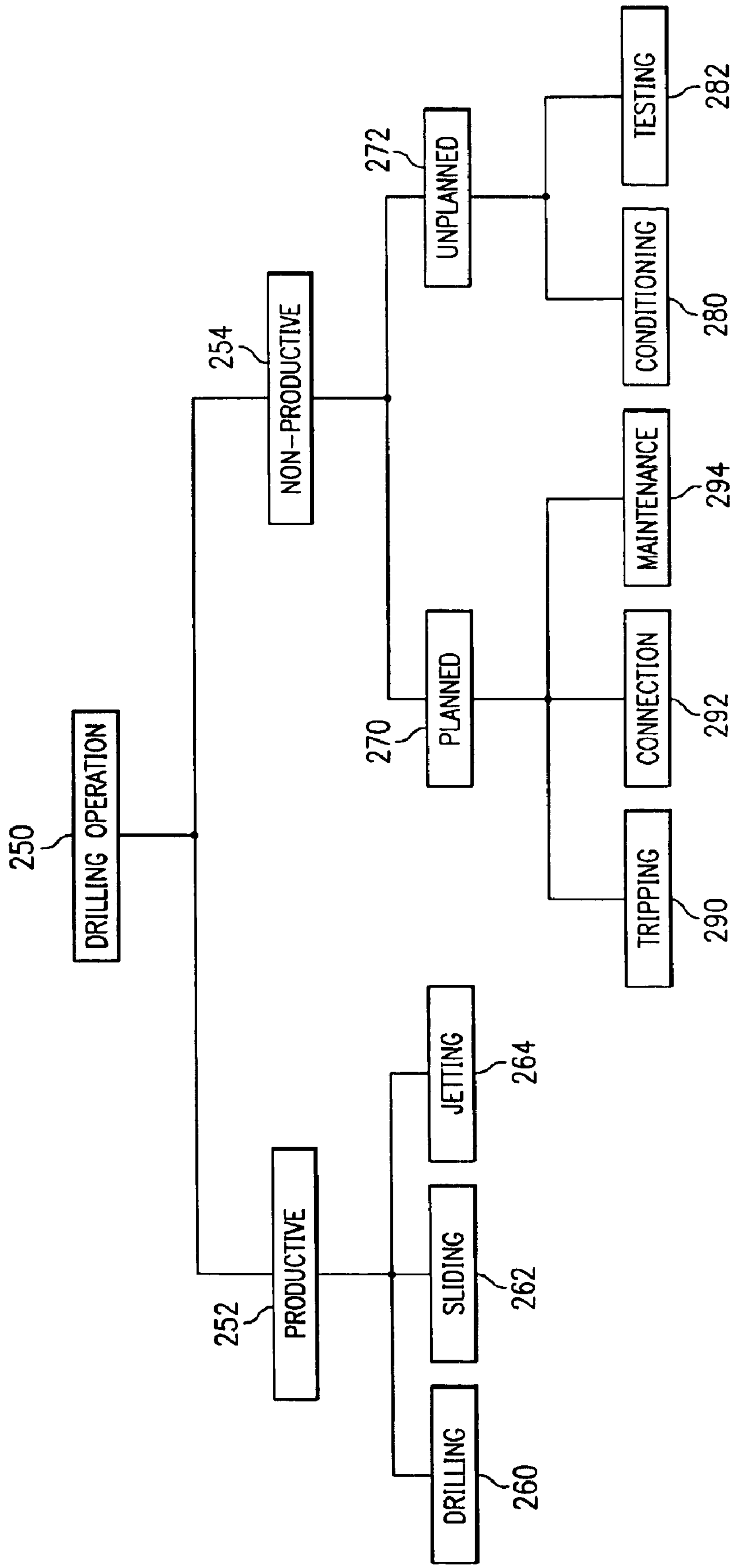

250
DRILLING OPERATION
252
PRODUCTIVE
254
NON-PRODUCTIVE
260
DRILLING
262
SLIDING
264
JETTING
270
PLANNED
272
UNPLANNED
290
TRIPPING
292
CONNECTION
294
MAINTENANCE
280
CONDITIONING
282
TESTING

FIG. 6

AUTOMATED METHOD AND SYSTEM FOR DETERMINING THE STATE OF WELL OPERATIONS AND PERFORMING PROCESS EVALUATION

TECHNICAL FIELD

This invention relates generally to the field of drilling management systems, and more particularly to an automated method and system for determining the state of drilling and other well operations and performing process evaluation.

BACKGROUND

Drilling rigs are typically rotary-typed rigs that use a sharp bit to drill through the earth. At the surface, a rotary drilling rig often includes a complex system of cables, engines, support mechanisms, tanks, lubricating devices, and pulleys to control the position and rotation of the bit below the surface.

Underneath the surface, the bit is attached to a long drill pipe which carries drilling fluid to the bit. The drilling fluid lubricates and cools the bit, as well as removes cuttings and debris from the well bore. In addition, the drilling fluid provides a hydrostatic head of pressure that prevents the collapse of the well bore until it can be cased and that prevents formation fluids from entering the well bore, which can lead to gas kicks and other dangerous situations.

Automated management of drilling rig operations is problematic because parameters may change quickly and because down hole behavior of drilling elements and down hole conditions may not be directly observable. As a result, many management systems fail to accurately recognize the presence and/or absence of important drilling events, which may lead to false alarms and unnecessary down time.

SUMMARY

The present invention provides an automated method and system for determining the state of drilling and other well operations. Process evaluation may be performed for the operation based on the state and dynamic data for the operation. In a particular embodiment, the present invention determines the state of drilling operations based on bit behavior to allow accurate and timely event recognition during drilling operations. In other embodiments, the present invention determines the state of work over, completion, testing, abandonment, intervention and/or other well operations of the drilling industry based on sensed, verified, inferred and/or determined mechanical and hydraulic data.

In accordance with one embodiment of the present invention, an automated method for monitoring the state of a well operation comprises storing a plurality of states for the well operation. Mechanical and hydraulic data is sensed and reported for the well operation. Based on the mechanical and hydraulic data, one of the states is automatically selected as the state of the well operation. The state may be used for process evaluation, decision making and control functionality.

Technical advantages of some embodiments of the present invention include providing an automated method and system for determining the state of a well operation based on mechanical and/or hydraulic data sensed, inferred, and/or determined for the operation. The data may be sensed and processed down hole and/or at the surface and in connection with operations for the well. As a result, well reporting, management or event recognition may be automatically provided in connection with the well operation.

Another technical advantage of some embodiments of the present invention includes providing an automated method and system for effectively determining the state of a drilling operation. In particular, the drilling, tripping, reaming, testing, and/or conditioning state of a rig may be determined in real time and used for reporting, event recognition and/or rig management.

Still another technical advantage of some embodiments of the present invention includes providing an improved drilling or other rig used for well operations. In particular, sensed and/or reported data is utilized to enhance accuracy. In addition, the automated and real time state determination may allow for earlier, more effective and more efficient recognition of potentially hazardous events such as kickouts, stuck pipe, and pack off, thus resulting in the more effective taking of corrective operations and a reduction in the frequency and severity of undesirable events.

It will be understood that the various embodiments of the present invention may include some, all, or none of the enumerated technical advantages. In addition, other technical advantages of the present invention may be readily apparent from the following figures, description and claims.

BRIEF DESCRIPTION

For a more complete understanding of the present invention and its advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a schematic diagram of a drilling rig in accordance with one embodiment of the present invention;

FIG. **2** is a block diagram of a monitoring system for a drilling operation in accordance with one embodiment of the present invention;

FIG. **3** is a flow diagram illustrating a method for monitoring a drilling operation in accordance with one embodiment of the present invention;

FIG. **4** is a flow diagram illustrating a method for determining the state of a drilling operation in accordance with one embodiment of the present invention;

FIGS. **5**A–B are flow diagrams illustrating a method for determining the state of a drilling operation in accordance with another embodiment of the present invention; and

FIG. **6** is a block diagram illustrating states for a drilling operation in accordance with another embodiment of the present invention.

DETAILED DESCRIPTION

The present invention provides an automated method and system for determining the state of well operations. In one embodiment, as described with particularity below, the present invention may be used to automatically determine the state of drilling operations. In other embodiments, as also described below, the present invention may be used to determine the state of mud fluid circulation and other drilling systems or subsystems, as well as the state of other suitable well operations. For example, the state engine of the present invention may be used to determine the status of work over, completion, re-entry, tubing runs and exchanges as well as other suitable well operations. The well operations may be rig-performed operations with a rig on site or other activity performed over the life of an oil, gas or other suitable well. In each of these embodiments, the well operations are typically complex processes in which state determination involves a number of parameters from a number of systems and/or locations. For example, a drilling

operation may include parameters measured and/or representing surface as well as down hole conditions and equipment. The state determination may be based on mechanical and hydraulic data, may be determined to a high resolution and/or may be determined based on input from a number of systems. Thus, the state engine may provide comprehensive state determination in order to support control evaluation and/or decision making functionality for a well operation. Control evaluation and/or decision making functionally is supported, in one embodiment, where operational conditions and status are provided and determined to allow accurate and automatic control of all, a substantial portion or at least a majority of aspects of well operations with little or no direct input from human operators.

FIG. **1** illustrates a drilling rig **10** in accordance with one embodiment of the present invention. In this embodiment, the rig **10** is a conventional rotary land rig. However, the present invention is applicable to other suitable drilling technologies and/or units, including top drive, power swivel, down hole motor, coiled tubing units, and the like, and to non-land rigs, such as jack up rigs, semisubmersables, drill ships, mobile offshore drilling units (MODUs), and the like that are operable to bore through the earth to resource-bearing or other geologic formations.

The rig **10** includes a mast **12** that is supported above a rig floor **14**. A lifting gear includes a crown block **16** mounted to the mast **12** and a travelling block **18**. The crown block **16** and the travelling block **18** are interconnected by a cable **20** that is driven by draw works **22** to control the upward and downward movement of the travelling block **18**.

The travelling block **18** carries a hook **24** from which is suspended a swivel **26**. The swivel **26** supports a kelley **28**, which in turn supports a drill string, designated generally by the numeral **30** in the well bore **32**. A blow out preventor (BOP) **35** is positioned at the top of the well bore **32**. The string may be held by slips **58** during connections and rig-idle situations or at other appropriate times.

The drill string **30** includes a plurality of interconnected sections of drill pipe or coiled tubing **34** and a bottom hole assembly (BHA) **36**. The BHA **36** includes a rotary drilling bit **40** and a down hole, or mud, motor **42**. The BHA **36** may also include stabilizers, drill collars, measurement well drilling (MWD) instruments, and the like.

Mud pumps **44** draw drilling fluid, or mud, **46** from mud tanks **48** through suction line **50**. The drilling fluid **46** is delivered to the drill string **30** through a mud hose **52** connecting the mud pumps **44** to the swivel **26**. From the swivel **26**, the drilling fluid **46** travels through the drill string **30** to the BHA **36**, where it turns the down hole motor **42** and exits the bit **40** to scour the formation and lift the resultant cuttings through the annulus to the surface. At the surface, the mud tanks **48** receive the drilling fluid from the well bore **32** through a flow line **54**. The mud tanks **48** and/or flow line **54** include a shaker or other device to remove the cuttings.

The mud tanks **48** and mud pumps **44** may include trip tanks and pumps for maintaining drilling fluid levels in the well bore **32** during tripping out of hole operations and for receiving displaced drilling fluid from the well bore **32** during tripping-in-hole operations. In a particular embodiment, the trip tank is connected between the well bore **32** and the shakers. A valve is operable to divert fluid away from the shakers and into the trip tank, which is equipped with a level sensor. Fluid from the trip tank can then be directly pumped back to the well bore via a dedicated centrifugal pump instead of through the standpipe.

Drilling is accomplished by applying weight to the bit **40** and rotating the drill string **30**, which in turn rotates the bit **40**. The drill string **30** is rotated within bore hole **32** by the action of a rotary table **56** rotatably supported on the rig floor **14**. Alternatively or in addition, the down hole motor may rotate the bit **40** independently of the drill string **30** and the rotary table **56**. As previously described, the cuttings produced as bit **40** drills into the earth are carried out of bore hole **32** by the drilling fluid **46** supplied by pumps **44**.

FIG. **2** illustrates a well monitoring system **68** in accordance with one embodiment of the present invention. In this embodiment, the monitoring system is a drilling monitoring system **68** for the rig **10**. The monitoring system **68** comprises a sensing system **70** and a monitoring module **80** for drilling operations of the rig **10**. Well monitoring systems for other well operations may comprise a sensing system with sensors similar, analogous or different to those of sensing system **70** for use in connection with a monitoring module, which may be similar, analogous or different than module **80**. As described in more detail below, drilling operations may comprise drilling, tripping, testing, reaming, conditioning, and other and/or different operations, or states, of the drilling system. A state may be any suitable operation or activity or set of operations or activities of which all, some or most are based on a plurality of sensed parameters.

The sensing system **70** includes a plurality of sensors that monitor, sense, and/or report data, or parameters, on the rig **10**, and/or in the bore hole **32**. The reported data may comprise the sensed data or may be derived, calculated or inferred from sensed data.

In the illustrated embodiment, the sensing system **70** comprises a lifting gear system **72** that reports data sensed by and/or for the lifting gear; a fluid system **74** that reports data sensed by and/or for the drilling fluid tanks, pumps, and lines; rotary system **76** that reports data sensed by and/or for the rotary table or other rotary device; and an operator system **78** that reports data input by a driller/operator. As previously described, the sensed data may be refined, manipulated or otherwise processed before being reported to the monitoring module **80**. It will be understood that sensors may be otherwise classified and/or grouped in the sensor system **70** and that data may be received from other additional or different systems, subsystems, and items of equipment. The systems that perform a well operation, which in some contexts may be referred to as subsystems, may each comprise related processes that together perform a distinguishable, independent, independently controllable and/or separable function of the well operation and that may interact with other systems in performing their function of the operation.

The lifting gear system **72** includes a hook weight sensor **73**, which may comprise digital strain gauges or other sensors that report a digital weight value once a second, or at another suitable sensor sampling rate. The hook weight sensor may be mounted to the static line (not shown) of the cable **20**.

The fluid system **74** includes a stand pipe pressure sensor **75** which reports a digital value at a sampling rate of the pressure in the stand pipe. The drilling fluid system may also include a mud pump sensor **77** that measures mud pump speed in strokes per minute, from which the flow rate of drilling fluids into the drill string can be calculated. Additional and/or alternative sensors may be included in the drilling fluid system **74** including, for example, sensors for measuring the volume of fluid in mud tank **46** and the rate of flow into and out of mud tank **46**. Also, sensors may be included for measuring mud gas, flow line temperature, and mud density.

The rotary system **76** includes a rotary table revolutions per minute (RPM) sensor **79** which reports a digital value at a sampling rate. The RPM sensor may also report the direction of rotation. A rotary torque sensor **83** may also be included which measures the amount of torque applied to drill string **34** during rotation. The torque may be indicated by measuring the amount of current drawn by the motor that draws rotary table **46**. The rotary torque sensor may alternatively sense the tension in the rotary table drive chain.

The operator system **78** comprises a user interface or other input system that receives input from a human operator/driller who may monitor and report observations made during the course of drilling. For example, bit position (BPOS) may be reported based upon the length of the drill string **30** that has gone down hole, which in turn is based upon the number of drill string segments the driller has added to the string during the course of drilling. The driller/operator may keep a tally book of the number of segments added, and/or may input this information in a Supervisory Control and Data Acquisition (SCADA) reporting system.

Other parameters may be reported or calculated from reported values. For example, other suitable hydraulic and/or mechanical data may be reported. Hydraulic data is data related to the flow, volume, movement, rheology, and other aspects of drilling or other fluid performing work or otherwise used in operations. The fluids may be liquid, gaseous or otherwise. Mechanical data is data related to support or physical action upon or of the drill string, bit or any other suitable device associated with the drilling or other operation. Mechanical and hydraulic data may originate with any suitable device operable to accept, report, determine, estimate a value, status, position, movement, or other parameter associated with a well operation. As previously described, mechanical and hydraulic data may originate from machinery sensor data such as motor states and RPMs and for electric data such as electric power consumption of top drive, mud transfer pumps or other satellite equipment. For example, mechanical and/or hydraulic data may originate from dedicated engine sensors, centrifugal on/off sensors, valve position switches, fingerboard open/close indicators, SCR readings, video recognition and any other suitable sensor operable to indicate and/or report information about a device or operation of a system. In addition, sensors for measuring well bore trajectory, and/or petrophysical properties of the geologic formations, as well down hole operating parameters, may be sensed and reported. Down hole sensors may communicate data by wireline, mud pulses, acoustic wave, and the like. Thus, the data may be received from a large number of sources and types of instruments, instrument packages and manufacturers and may be in many different formats. The data may be used as initially reported or may be reformatted and/or converted. In a particular embodiment, data may be received from two, three, five, ten, twenty, fifty, a hundred or more sensors and from two, three, five, ten or more systems. That data and/or information determined from the data may be a value or other indication of the rate, level, rate of change, acceleration, position, change in position, chemical makeup, or other measurable information of any variable of a well operation.

The monitoring module **80** receives and processes data from the sensing system **70** or from other suitable sources and monitors the drilling system and conditions based on the received data. As previously described, the data may be from any suitable source, or combinations of sources and may be received in any suitable format. In one embodiment, the monitoring system **80** comprises a parameter calculator **81**,

a parameter validator **82**, a drilling state determination detector **84**, an event recognition module **86**, a database **96**, a flag log **94**, and a display/alarm module **97**. It will be understood that the monitoring system **80** may include other or different programs, modules, functions, database tables and entries, data, routines, data storage, and other suitable elements, and that the various components may be otherwise integrated or distributed between physically disparate components. In a particular embodiment, the monitoring module **80** and its various components and modules may comprise logic encoded in media. The logic may comprise software stored on a computer-readable medium for use in connection with a general purpose processor, or programmed hardware such as application-specific integrated circuits (ASIC), field programmable gate arrays (FPGA), digital signal processors (DSP) and the like.

The parameter calculator **81** derives/infers or otherwise calculates state indicators for drilling operations based on reported data for use by the remainder of monitoring system **80**. Alternatively, the calculations could be conducted by processes or units within the sensing systems themselves, by an intermediary system, the drilling state detector **84**, or by the individual module of the monitoring system **80**. A state indicator is a value or other parameter based on sensed data and is indicative of the state of drilling operations. In one embodiment, the state indicators comprise measured depth (MD), hook load (HKLD), bit position (BPOS), stand pipe pressure (SPP), and rotary table revolutions per minute (RPM).

The state indicators, either directly reported or calculated via calculator **81** and other parameters, may be received by the parameter validator **82**. The parameter validator **82** recognizes and eliminates corrupted data and flags malfunctioning sensor devices. In one embodiment, the parameter validation compares each parameter to a status and/or dynamic allowable range for the parameter. The parameter is flagged as invalid if outside the acceptable range. As used herein, each means every one of at least a subset of the identified items. Reports of corrupted data or malfunctioning sensor devices can be sent to and stored in flag log **94** for analysis, debugging, and record keeping.

The validator **82** may also smooth or statistically filter incoming data. Validated and filtered parameters may be directly utilized for event recognition, or may be utilized to determine the state drilling operations of the rig **10** via the drilling state determination detector **84**.

The drilling state determination detector **84** uses combinations of state indicators to determine the current state of drilling operations. The state may be determined continuously at a suitable update rate and in real time. A drilling state is an overall conclusion regarding the status of the well operation at a given point in time based on the operation of and/or parameters associated with one or more key drilling elements of the rig. Such elements may include the bit, string, and drilling fluid.

In one embodiment, the drilling state determinator modules **84** stores a plurality of possible and/or predefined states for drilling operations for the rig **10**. The states may be stored by storing a listing of the states, storing logic differentiating the states, storing logic operable to determine disparate states, predefining disparate states or by otherwise suitably maintaining, providing or otherwise storing information from which disparate states of an operation can be determined. In this embodiment, the state of drilling operations may be selected from the defined set of states based on the state indicators. For example, if the bit is substantially off

bottom, there is no substantial rotation of the string, and drilling fluid is substantially circulating, then based on this set of state indicators, drilling state detector **84** determines the state of drilling operations to be and/or described as circulating off bottom. On the other hand, if the drill bit is moving into the hole and the string is rotating, but there is no circulation of drilling fluid, the state of drilling operations can be determined to be and/or described as working pipe. Examples and explanations of these and other drilling states and their determination by the drilling state determination module **84** may be found in reference to FIGS. **4** and **5**. The states may be stored locally and/or remotely, may be titled or untitled, may be represented by any suitable type of signal and may be determined mathematically, by comparisons, by logic trees, by lookups, by expert systems such as an inferencing engine and in any other suitable manner. The states may be sections or parts of a continuous spectrum. Thus, for example, the state may be determined by selection of a predefined state based on matching criteria and/or one or more comparisons. The state may be determined repetitively, continuously, substantially continuously or otherwise. A process is substantially continuous when it is continuous for a majority of processes for a well operation and/or cycles on a periodic basis on the order of magnitude of a second, or less.

The event recognition module **86** receives drilling parameters and/or drilling state conclusions and recognizes or flags events, or conditions. Such conditions may be alert conditions such as hazardous, troublesome, problematic or noteworthy conditions that affect the safety, efficiency, timing, cost or other aspect of a well operation. For drilling operations, drilling events comprise potentially significant, hazardous, or dangerous happenings or other situations encountered while drilling that may be important to flag or bring to the attention of a drilling supervisor. Events may include stuck pipe, pack off, or well control events such as kicks.

The event recognition module **86** may comprise sub-modules operable to recognize different kinds of events. For example, well control events such as kick-outs may be recognized via operation of well control sub-module **88**. A well control event is any suitable event associated with a well that can be controlled by application or adjustment of a well fluid, flow, volume, or device such as circulation of fluid during drilling operations. Pack-off events, such as, for example, when drill cuttings clog the annulus, may be recognized via operation of pack-off sub-module **90**, and stuck pipe events may be recognized via operation of stuck pipe sub-module **92**. Other events may be useful to recognize and flag, and the event recognition module **86** may be configured with other modules with which this is accomplished. Control evaluation and/or decisions may be performed continuously, repetitively and/or substantially continuously as previously described. In another embodiment, the state and event recognition may be performed in response to one or more predefined events or flags that arise during the well operation.

Drilling parameters, drilling states, event recognitions, and alert flags may be displayed to the user on display/alarm module **97**, stored in database **96**, and/or made accessible to other modules within monitoring system **80** or to other systems or users as appropriate. Database **96** may be configured to record trends in data over time. From these data trends it may be possible, for example, to infer and flag long-term effects such as bore-hole degradation caused by repeated tripping within the bore hole.

In operation, the monitoring system **80** may allow for an increase in quality control with respect to sensing devices and the monitoring of the timing and efficiency of drilling operations. Events such as kickouts may be accurately detected and flagged while drilling earlier than is possible via human observation of rig operations, thus resulting in the more effective taking of corrective operations and a reduction in the frequency and severity of undesirable events. In addition, the provisioning of state information may allow false alarms to be minimized, more accurate event recognition and residual down time. Another potential benefit may be an increased ability to automate daily and end-of-well reporting procedures.

The states may be determined, control evaluation provided, and/or events recognized without manual or other input from an operator or without direct operator input. Operator input may be direct when the input forms a state indicator used directly by the state engine. In addition, the state, evaluation and recognition processes may be performed without substantial operator input. For example, processes may run independently of operator input but may utilize operator overrides of erroneous readings or other analogous inputs during instrument or other failure conditions. It will be understood that a process may run independently of operator input during operation and/or normal operation and still be manually, directly, or indirectly started, initiated, interrupted or stopped. With or without operator input, the state recognition processes are substantially based on instrument sensed parameters that are monitored in real-time and dynamically changing.

FIG. **3** illustrates a method for monitoring a rig in accordance with one embodiment of the present invention. In this embodiment, the state of drilling operation is determined and drilling events are recognized based on operational data and the drilling state. It will be understood that events may be otherwise determined or suitably recognized and that drilling may be otherwise suitably monitored without departing from the scope of the present invention.

Referring to FIG. **3**, the method begins at step **100** with the receipt of reported data by the monitoring system **80**, while the rig is operating. The data may be from the lifting gear system **72**, the drilling fluid system **74**, the rotary system **76**, the driller/operator system **78** and/or from other sensors or systems of the drilling rig **10**. Some of the data may constitute parameters usable in their present form or format. In other cases, state indicators or other parameters are calculated from the reported data at step **102**.

At step **104**, the parameters are validated and filtered. Validation may be accomplished by comparing the parameters to pre-determined or dynamically determined limits, and the parameters used if they are within those limits. Filtering may occur via the use of filtering algorithms such as Butterworth, Chebyshev type I, Chebyshev type II, Elliptic, Equiripple, least squares, Bartlett, Blackman, Boxcar, Chebyshev, Hamming, Hann, Kaiser, FFT, Savitzky Golay, Detrend, Cumsum, or other suitable data filter algorithms.

Next, at decisional step **106**, for any data failing validation, the No branch of decisional step **106** leads to step **108**. At step **108**, the invalid data is flagged and recorded in the flag log. After flagging, step **108** leads back to step **100**. Determinations based on inputs for which invalid data was received may be omitted during the corresponding cycle. Alternatively, a previous value of the input may be used, or a value based on a trend of the input may be used.

Returning to decisional step **106**, for those parameters that are validated, the Yes branch leads to step **110**. At step **110**, validated and filtered operational parameters may be utilized

to determine the state of drilling operations of the rig **10**. The drilling state determined at step **110** and data trends may be recorded in the database **96** at step **112**. At step **114**, drilling state information and operational parameters are utilized to recognize drilling events, as described above.

Proceeding to decisional step **116**, if the rig **10** remains in operation, the Yes branch returns to step **100** and continues the method as long as the rig is operational. If the rig **10** is deactivated or otherwise not operational, the No branch of decisional step **116** leads to the end of the process. The process may be operated once or more times per second, or at other suitable intervals. In this way, continuous and real time monitoring of drilling operations may be provided.

FIG. **4** illustrates a method for determining the state of drilling operations for the drilling rig **10** in accordance with one embodiment of the present invention. In this embodiment, the drilling states of the drilling rig **10** may comprise and/or be divided into three general categories: (1) drilling; (2) testing/conditioning operations; and (3) tripping/reaming. The drilling state or states include those where the rig **10** is operating so as to drill through the earth or to attempt to do so by the rotation of the drilling bit **40**. Drilling may include jetting, or washing, in part, in whole or otherwise as well as any operation operable to bore through the earth and/or remove earth from a bore hole. Jetting may be using mainly hydraulic force for rock destruction. Thus, drilling may include hammer/percussion and laser drilling. It will be understood that unsuccessful drilling may be a separate state or states. The testing/conditioning state or states are operations (other than tripping or reaming operations) used to check or test certain aspects of equipment performance, change out bits, line, or other equipment, change to a different drilling mud, condition a particular part of the bore annulus, or similar operations. The tripping/reaming state or states are operations that include the travel of the bit up or down the already-drilled bore hole.

In the embodiment shown in FIG. **4**, four types of state indicators are considered by the drilling state detector **84** in determining the state of drilling operations: (1) whether the rig is "making hole" (substantially increasing the total length of the bore hole), (2) whether the bit is substantially on bottom, (3) whether the bit position is substantially constant, and (4) whether there is substantial circulation of the drilling fluid.

Referring to FIG. **4**, the method begins at step **132** in which the parameter calculator **81**, drilling state detector **84**, or other logic determines whether the drilling rig **10** is making hole. This may be done by determining whether the measured depth of the hole is increasing. If hole is being made, the Yes branch of decisional step **137** leads to step **134**. At step **134**, the drilling state detector **84** determines that drilling operations are occurring.

Returning to decisional step **132**, if hole is not being made, the No branch leads to decisional step **136**. At step **136**, the detector **84** determines whether the drill bit is at bottom of the bore hole **32**. In one embodiment, the drill bit is at the bottom of the bore hole if the measured depth is equal to bit position.

If the bit is on the bottom, the Yes branch of decisional step **136** leads to decisional step **142**, where detector **84** determines whether drilling fluid is circulating through the drill string **30**, out of the drill bit **40**, and through the rest of the fluid system. Parameters used for making this determination may include stand pipe pressure (SPP), strokes per minute (SPM) of the mud pump, total strokes, inflow rate, outflow rate, triptank level, mud pit level, or other suitable hydraulic parameters. A lower limit of these parameters may be chosen for making the determination; for example, experience may show that a SPP of greater than twenty psi is indicative that the drilling fluid is substantially circulating within the hydraulic system.

If circulation is occurring at decisional step **142**, detector **84** concludes that drilling operations are occurring, suggesting that relatively strong rock at the bottom of the bore is resulting in a situation where drilling operations are occurring, but little or no hole is being made. Accordingly, the Yes branch of decisional step **142** leads to step **134**.

Returning to decisional step **142**, if there is not circulation, the method concludes at step **144** that the drilling state of the rig **10** is undergoing testing/conditioning operations.

Returning to decisional step **136**, if the bit is not on the bottom, the No branch leads to decisional step **138** wherein it is determined whether bit position within the hole is constant; that is, whether the position of the bit relative to the terminus of the bore is remaining constant. If the bit position is constant, the Yes branch leads to step **144** where, as previously described, it is determined that the drilling state of the rig **10** is undergoing testing/conditioning operations. Returning to decisional step **138**, if the bit position is not constant, the No branch leads to step **140**. At step **140**, the drilling state is determined to be tripping and/or reaming operations.

After the drilling state of the rig is determined based on steps **134**, **144**, or **140**, the process leads to decisional step **146**, where it is determined whether operations continue. If operations continue, the Yes branch returns to decisional step **132**, where the drilling state of the rig continues to be determined as long as the operations continue. If operations are at an end, the No branch of decisional step **146** leads to the end of the process where the drilling state is determined repetitively and/or substantially continuously and in real and/or near real time.

It will be understood that other, additional or a subset of these states may be used for drilling operations. For example, in another embodiment, the states may comprise a drilling/reaming state indicating formation or other material being removed from a bore hole, a tripping state indicating tripping in or out of the hole, a testing/condition state indicating those operations and a connection/maintenance state indicating a process interruption. In still another embodiment, as described in connection with FIG. **5**, the state detector **84** may have a high resolution or granularity with five, ten, fifteen or more states. As previously described, the resolution, and thus number and type of states is preferably selected to support control evaluation, decision making and/or provide process evaluation. Process evaluation may be evaluation of parameters, information and other data in the control and decision making context. For example, process evaluation may provide indications and warnings of hazardous events. Data and/or state reporting for archiving may also be provided.

FIGS. **5**A–B illustrate a method for determining the drilling state of the drilling rig **10** in accordance with another embodiment of the present invention. In this embodiment, granularity of the drilling states is increased to support enhanced monitoring, reporting, logging and event recognition capabilities. In particular, each of the drilling operations state, the testing/conditioning operations state, and the tripping/reaming operations state are subdivided into a plurality of states.

In one embodiment, drilling state is subdivided into rotary drilling state (stated simply as "drilling" on FIG. **5**) and

sliding state. Rotary drilling occurs when the rotation of the bit **40** is caused at least in part by the rotation of the drill string **30** which, in turn, is caused by the rotation of the rotary table **56** or other device. In sliding, bit rotation is caused by the operation of a down hole bit motor or turbine rather than by the rotation of the drill string **30**. In one embodiment, rotary drilling may include sliding and washing and sliding may include washing.

Likewise, testing/conditioning operations are subdivided into an in slips state, a slip and cut line state, a flow check on bottom state, a bore hole conditioning state, a circulating off bottom state, a parameter check state, and a flow check off bottom state.

In slips occurs when the string **30** is set in slips and the string weight is off the hook **24**. This state typically occurs during connections and rig-idle situations. Slip and cut line occurs when the string is set in slips and the travelling block assembly is removed so as to, for example, replace worn drilling line. Flow check on bottom occurs when drilling fluid **46** is not circulating and the bit position is on bottom and static. Bore hole conditioning occurs when drilling fluid **46** is circulating, bit position is static and off bottom, and string **30** is rotating. Bore hole conditioning typically occurs when the well bore **32** is being conditioned by cleaning out cuttings or other resistance in the drill pipe/bore-hole-wall annulus. Circulating off bottom occurs when the bit **40** is off bottom, there is no rotation of the string **30**, and drilling fluid **46** is circulating. Circulating off bottom typically occurs when mud is changed, fluid pills are placed, or if the well is cleaned out. Parameter check occurs when the string **30** is off bottom and rotating, and drilling fluid **46** is not circulating. Hook load may be measured during parameter check to be used for torque and drag simulations. Flow check off bottom occurs when drilling fluid **46** is not circulating and bit position is static and off bottom. Flow check off bottom typically occurs during a check to determine if the well is flowing (gaining formation fluid) or losing (drilling mud is flowing into formation).

Tripping/reaming operations can be subdivided into a tripping in hole (TIH) state, a tripping out of hole (TOH) state, a reaming while TIH state, a reaming while TOH state, a working pipe state, a washing while TIH state, and a washing while TOH state.

Tripping in hole (TIH) occurs when re-entering a hole after pulling back to the surface. Alone, the term describes TIH with no rotation and no circulation. Tripping out of hole (TOH) occurs when pulling bit off bottom for a short or round trip to surface. Alone, the term describes TOH with no rotation and no circulation. Reaming occurs when the drill bit is moving into the hole, drilling fluid is circulating, and string is rotating. Reaming while TIH is typically used in order to clean out cuttings or other obstructions. Reaming while TOH ("back reaming") is used with dedicated back-reaming tools to clean out sedimented cuttings or obstructions. Working pipe (while TIH or TOH) occurs when the drill bit is moving into the hole, string is rotating, but there is no circulation of drilling fluid. Working pipe is typically used to manage stabilizers or to move the bit past restrictions or ease the movement of the drill string in horizontal well-sections. Washing (while TIH or TOH) occurs when the drill bit is moving into the hole, string is not rotating, and drilling fluid is circulating. Washing while TIH typically is utilized to wash out cuttings before setting the bit on bottom for drilling.

Referring to FIG. **5**, the method begins at step **152** where it is determined, similar to the embodiment described in FIG. **4**, whether the rig is making hole. Specifically, step **152** may make this determination by determining whether or not the measured depth is increasing. If measured depth is increasing, the method then determines at step **172** whether the RPM of the rotary table are greater than or equal to one. If the RPM of the rotary table is greater than or equal to one, it is determined at step **194** that rotary table drilling is occurring. If the RPM is less than one at decisional step **172**, then it is determined that the rig is sliding.

Returning to decisional step **152**, if the measured depth is not increasing, it is next determined at decisional step **154** if the bit position is equal to the measured depth. If the bit position is equal to the measured depth, then at step **164** it is determined whether there is circulation. In the illustrated embodiment, the parameter of stand pipe pressure is used to determine the circulation parameter such that if the stand pipe is greater than or equal to twenty pounds per square inch (psi), then circulation of drilling fluid is determined to be occurring.

At decisional step **174**, it is determined whether or not the RPM of the rotary table is greater than or equal to one. Again, if the RPM is greater than or equal to one, the rig is determined to be (rotary table) drilling and if the RPM is not greater than or equal to one, the rig is determined to be sliding in accordance with steps **198** and **200**, respectively. Returning to step **164**, if the stand pipe pressure is less than twenty psi, then the drilling behavior is determined at step **212** to be flow check on bottom.

Returning to step **154**, if the bit position does not equal measured depth, then at step **156** it is determined whether or not the bit position is constant. If the bit position is constant, at step **160** it is next determined whether the hook load is greater than bit weight. If the hook load is greater than bit weight, at step **166** it is determined whether the stand pipe pressure is greater than or equal to twenty psi. If the stand pipe pressure is greater than or equal to twenty psi, then at step **176** it is determined whether the RPM is greater than or equal to one. If the RPM is greater than or equal to one, the drilling behavior is determined to be bottom hole conditioning at step **204**. If the RPM is not greater than or equal to one, then, at step **206**, the status is determined to be circulating off bottom.

Returning to step **166**, if the stand pipe is less than twenty psi, then, at step **178**, it is determined whether the RPM is greater than or equal to one. If the RPM is greater than or equal one, at step **208**, the drilling behavior is determined to be parameter check. If the RPM is not greater than or equal to one, the drilling behavior is determined at step **210** to be flow check off bottom.

Returning to decisional step **160**, if the hook load is not greater than the bit weight, it is next determined at step **162** whether the hook load equals the bit weight. The hook load may equal bit weight if it is the same or substantially the same as the bit weight or within specified deviation of the bit weight. If the hook load equals the bit weight, the drilling behavior is determined to be in slips at step **190**. If the hook load does not equal the bit weight, at step **192**, the drilling behavior is determined to be in slips with the line cut above the slips.

Returning to decisional step **156**, if the bit position is not constant, it is next determined at decisional step **158** whether the bit position is increasing. If the bit position is increasing, then at step **168** it is determined whether the RPM is greater than or equal to one. If the RPM is greater than or equal to one, at step **180** it is determined whether the stand pipe pressure is greater than or equal to twenty psi. If the stand

pipe pressure is greater than or equal to twenty psi, the drilling behavior is determined to be reaming while tripping in hole at step **212**. If the stand pipe pressure is less than twenty psi, then at step **214** the status is determined to be working pipe while tripping in hole.

If the RPM is less than one at decisional step **168**, it is then determined at step **182** whether the stand pipe pressure is greater than or equal to twenty psi. If the stand pipe pressure is greater than or equal to twenty psi, the status is determined to be washing while tripping in hole at step **216**. If the stand pipe pressure is less than twenty psi, the status is determined to be tripping in hole at step **218**.

Returning to decisional step **158**, if the bit position is not increasing, it is next determined at step **170** whether the RPM is greater than or equal to one. If the RPM is greater than or equal to one, at step **184**, it is determined whether the stand pipe pressure is greater than or equal to twenty psi. If the stand pipe pressure is greater than or equal to twenty psi, at step **220** the status is determined to be back reaming. If the stand pipe pressure is less than twenty psi, at step **222** the status is determined to be working pipe while tripping out of hole.

Returning to decisional step **170**, if the RPM is not greater than or equal to one, at step **186**, if the stand pipe pressure is greater than or equal to twenty psi, then the drilling behavior is at step **224** determined to be washing while tripping out of hole. If the stand pipe pressure is less than twenty psi at step **186**, the drilling behavior is at step **226** determined to be tripping out of hole. After the drilling behavior has been determined, it is next determined at step **228** whether or not operations continue. If operations continue, then parameters continue to be entered into the system and the determination method continues. If operations are not continuing, then the method has reached its end.

FIG. **6** illustrates states of a well operation in accordance with another embodiment of the present invention. In this embodiment, the state of a drilling or other well operation may include hierarchal states with parent and child states. For example, a drilling or other well operation **250** may have a productive state **252** and a non-productive state **254**. For drilling operations, the productive state **252** may include processes in which hole is being made, the bit is advancing or is operated so as to advance. In a particular embodiment, the productive state may include and/or have drilling **260**, sliding **262** and/or jetting **264** or combination states as described in connection with FIG. **5**. In some drilling embodiments, reaming may be included in the productive state. In other well operations, the productive state may be the state that is the focus or ultimate purpose of the well operation.

The non-productive state **254** may include support or other processes that are planned, unplanned, needed, necessary or helpful to the production state or states. The non-productive state may include and/or have a planned state **270** and an unplanned state **272**. For drilling operations, the unplanned state **272** may include and/or have a conditioning state **280** and a testing state **282**. The planned state may include and/or have a tripping state **290** as well as a connection state **292** and a maintenance state **294**. Maintenance may include rig and hole maintenance. It will be understood that some operations, such as tripping may have aspects in both planned and unplanned states. The states may be determined based on state indicators and data as previously described with the parent and/or child states being determined and used for process evaluation. The parent states may be determined based on the previously discussed state indicators of the included, or underlying, child states, a subset of the indicators or otherwise. Thus, for example, the drilling operation **250** may have the productive state **252** if measured hole depth is increasing or if bit position is equal to measured hole depth and stand pipe pressure is greater than or equal to 20 psi. Maintenance may, for example, include hole maintenance such as reaming and/or rig maintenance such as slip and cut line.

Although the present invention has been described with reference to drilling rig **10** and the corresponding states of drilling operations, the invention may be used to determine one or more states associated with other suitable petroleum and geosystem operations for a well. Such well operations may include work-over procedures, well completions, natural-gas operations, well testing, cementing, well abandonment, well stimulation, acidizing, squeeze jobs, wire line applications and water/fluid treatment.

For example, mud fluid circulation systems generally include a series of stages that may be identified by using mechanical and hydraulic data as feedback from the associated system. Mud fluid circulation systems are generally used to maintain hydrostatic pressure for well control, carry drill cuttings to the surface, and cool and/or lubricate the drill bit during drilling. The mud or water used to make up the drilling fluid may require treatment to remove dissolved calcium and/or magnesium. Soda ash may be added to form a precipitate of calcium carbonate. Caustic soda (NaOH) may also be added to form magnesium hydroxide. Accordingly, fluid characteristics (such as pressure and fluid-flow rate) and chemical-based parameters may be suitably monitored in accordance with the teachings of the present invention in order to determine one or more of the identified states or other states of the operations.

In addition, production procedures and activities (such as fracs, acidizing, and other well-stimulating techniques) represent another example of petroleum operations within the scope of the present invention. Production operations may encompass any operations involved in bringing well fluids (or natural gas) to the surface and may further include preparing the fluids for transport to a suitable refinery or a next processing destination, and well treatment procedures used generally to optimize production. The first step in production is to start the well fluids flowing to the surface (generally referred to as "well completion"). Well servicing and workover consists of performing routine maintenance operations (such replacing worn or malfunctioning equipment) and performing more extensive repairs, respectively. Well servicing and workover are an intermittent step and generally a prerequisite in order to maintain the flow of oil or gas. Fluid may be then separated into its components of oil, gas, and water and then stored and treated (for purification), suitably measured, and properly tested where appropriate before being transported to a refinery. Well workovers may additionally involve recompletion in a different pay zone by deepening the well or by plugging back. In accordance with the teachings of the present invention, each of these procedures may be monitored such that feedback is provided in order to determine one or more of the identified states or other states of the corresponding operation.

Additionally, well or waste treatments represent yet another example of petroleum operations that include various stages that may be identified with use of the present invention. Well or waste treatments generally involve the use of elements such as: paraffin, slop oil, oil and produced water-contaminated soils. In well or waste treatments, purification and refinement stages could provide suitable feed-

back in offering mechanical data for selecting a corresponding state. Such states may include, for example, collecting, pre-treatment, treatment, settling, neutralization and out pumping.

Thus the monitoring system of the present invention may be used in connection with any suitable system, architecture, operation, process or activity associated with petroleum or geosystem operations of a well capable of providing an element of feedback data such that a stage associated with the operation may be detected, diagnosed, or identified is within the scope of the present invention. In these operations, the drilling rig **10** may not be on location. In these embodiments, such as in connection with frac jobs and stimulation, sensor data may be retrieved via wireline and/or mud pulses from down hole equipment and/or directly from surface equipment and systems.

In non-drilling applications, any suitable reference point may be tracked. For example, for pumping operations, pure volumetric data may be tracked and used to determine the state of operations. In all of these embodiments, the monitoring system may include a sensing system for sensing, refining, manipulating and/or processing data and reporting the data to a monitoring module. The sensed data may be validated and parameters calculated as previously described in connection with monitoring module **80**. The resulting state indicators may be fed to a state determination module to determine the current state of the operation. The state is the overall conclusion regarding the status at a given point and time based on key measurable elements of the operation. For example, for frac operations, the states may include high and low pressure states, fluid and slurry pumping states, proppant states, and backwash/cleansing states. For acid jobs, the states may include flow and pressure states, pumping states, pH states, and time-based states. Well completion operations may include testing, pumping, cementing and perforating states. For each of these and other well operations, the sensing system may include fluid systems, operator systems, pumping systems, down hole systems, surface systems, chemical analysis systems, and other systems operable to measure and provide data on the well operation.

As previously described, the state determinator module may store a plurality of possible and/or predefined states for the operation. In this embodiment, the state of operations may be selected from the defined set of states based on the state indicators. Events for the operation may be recognized and flagged as previously described.

Although the present invention has been described with several embodiments, various changes and modifications may be suggested to one skilled in the art. It is intended that the present invention encompass such changes and modifications as fall within the scope of the appended claims.

What is claimed is:

1. An automated method for determining the state of a well operation, comprising:

storing a plurality of states for a well operation;

receiving mechanical and hydraulic data reported for the well operation from a plurality of systems; and

determining that at least some of the data is valid by comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data; and

when the at least some of the data are valid, based on the mechanical and hydraulic data, automatically selecting one of the states as the state of the well operation.

2. The method of claim **1**, wherein the well operation comprises a drilling operation.

3. The method of claim **2**, wherein at least one of the plurality of states comprises a drilling state.

4. The method of claim **3**, wherein the drilling state comprises rotary drilling.

5. The method of claim **3**, wherein the drilling state comprises sliding.

6. The method of claim **2**, wherein the plurality of states comprises a testing state.

7. The method of claim **6**, wherein the testing state comprises a flow check on bottom.

8. The method of claim **6**, wherein the testing state comprises a flow check off bottom.

9. The method of claim **6**, wherein the testing state comprises a parameter check.

10. The method of claim **2**, wherein at least one of the plurality of states comprises a conditioning state.

11. The method of claim **10**, wherein the conditioning state comprises bottom hole conditioning.

12. The method of claim **10**, wherein the conditioning state comprises circulating off bottom.

13. The method of claim **2**, wherein at least one of the plurality of states comprises a tripping state.

14. The method of claim **13**, wherein the tripping state comprises tripping in hole.

15. The method of claim **13**, wherein the tripping state comprises reaming while tripping in hole.

16. The method of claim **13**, wherein the tripping state comprises working pipe while tripping in hole.

17. The method of claim **13**, wherein the tripping state comprises washing while tripping in hole.

18. The method of claim **13**, wherein the tripping state comprises back reaming while tripping out of hole.

19. The method of claim **13**, wherein the tripping state comprises working pipe while tripping out of hole.

20. The method of claim **13**, wherein the tripping state comprises washing while tripping out of hole.

21. The method of claim **2**, wherein the plurality of states comprises at least a drilling state, a testing state, and a tripping state.

22. The method of claim **2**, further comprising:

determining, based on the mechanical data, whether the hole is being made; and

wherein automatically selecting one of the states comprises selecting the state of the drilling operation based on whether the rig is making hole.

23. The method of claim **2**, further comprising:

determining, based on the mechanical data, whether a drilling bit is on bottom; and

wherein automatically selecting one of the states as the state of the well operation comprises selecting the state of the drilling operation based on whether the drilling bit is on bottom.

24. The method of claim **2**, further comprising:

determining, based on the hydraulic data, whether a drilling fluid is circulating; and

wherein automatically selecting one of the states as the state of the well operation comprises selecting the state of the drilling operation based on whether the drilling fluid is circulating.

25. The method of claim **2**, further comprising:

determining, based on the mechanical data, whether a bit position is constant; and

wherein automatically selecting one of the states as the state of the well operation comprises selecting the state

of the drilling operation based on whether the bit position is constant.

26. The method of claim **2**, further comprising indicating the state of the drilling operation.

27. The method of claim **2**, further comprising recognizing a drilling event based on the state of the drilling operation and data reported for the drilling operation.

28. The method of claim **2**, wherein at least one of the plurality of states comprises an in slips state.

29. The method claim **2**, wherein at least one of the plurality of states comprises a slip and cut line state.

30. The method of claim **1**, further comprising using the state of the well operation to evaluate parameters and provide control for the well operation.

31. An automated system for determining the state of a well operation comprising:

means for storing a plurality of states for a well operation;

means for determining that at least some received mechanical and hydraulic data is valid by comparing the at least some of the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data does not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data; and

means for automatically selecting one of the states based on mechanical and hydraulic data as the state of the well operation when the at least some of the mechanical and hydraulic data are valid.

32. The system of claim **31**, wherein the well operation comprises a drilling operation.

33. The system of claim **32**, wherein at least one of the plurality of the states comprises a drilling state.

34. The system of claim **33**, wherein the drilling state comprises rotary drilling.

35. The system of claim **33**, wherein the drilling state comprises sliding.

36. The system of claim **32**, wherein the plurality of states comprises a testing state.

37. The system of claim **36**, wherein the testing state comprises a flow check on bottom.

38. The system of claim **36**, wherein the testing state comprises a flow check off bottom.

39. The system of claim **36**, wherein the testing state comprises a parameter check.

40. The system of claim **32**, wherein at least one of the plurality of states comprises a conditioning state.

41. The system of claim **40**, wherein the conditioning state comprises bottom hole conditioning.

42. The system of claim **40**, wherein the conditioning state comprises circulating off bottom.

43. The system of claim **32**, wherein at least one of the plurality of states comprises a tripping state.

44. The system of claim **43**, wherein the tripping state comprises tripping in hole.

45. The system of claim **43**, wherein the tripping state comprises reaming while tripping in hole.

46. The system of claim **45**, wherein the tripping state comprises working pipe while tripping in hole.

47. The system of claim **45**, wherein the tripping state comprises washing while tripping in hole.

48. The system of claim **45**, wherein the tripping state comprises back reaming while tripping out of hole.

49. The system of claim **45**, wherein the tripping state comprises working pipe while tripping out of hole.

50. The system of claim **45**, wherein the tripping state comprises washing while tripping out of hole.

51. The system of claim **32**, wherein the plurality of states comprises at least a drilling state, a testing state, and a tripping state.

52. The system of claim **32**, further comprising:

means for determining whether the hole is being made based on the mechanical data; and

means for determining the state of the drilling operation based on whether the rig is making hole.

53. The system of claim **32**, further comprising:

means for determining whether a drilling bit is on bottom based on the mechanical data; and

means for determining the state of the drilling operation based on whether the drilling bit is on bottom.

54. The system of claim **32**, further comprising:

means for determining whether a drilling fluid is circulating based on the hydraulic data; and

means for determining the state of the drilling operation based on whether the drilling fluid is circulating.

55. The system of claim **32**, further comprising:

means for determining whether a bit position is constant based on the mechanical data; and

means for determining the state of the drilling operation based on whether the bit position is constant.

56. The system of claim **32**, further comprising means for indicating the state of the drilling operation.

57. The system of claim **32**, further comprising means for recognizing a drilling event based on the state of the drilling operation and data reported for the drilling operation.

58. The system of claim **32**, wherein at least one of the plurality of states comprises an in slips state.

59. The system claim **32**, wherein at least one of the plurality of states comprises a slip and cut line state.

60. The system of claim **31**, further comprising means for using the state of the well operation to evaluate parameters and provide control for the operation.

61. An automated system for determining the state of a well operation, comprising:

logic encoded in media; and

the logic operable to receive mechanical and hydraulic data reported for the well operation from a plurality of systems, determine that at least some of the received data is valid by comparing the at least some of the received data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the received data do not accurately represent the condition purportedly represented by the at least some of the received data, and to automatically select one of the states as the state of the well operation based on the mechanical and hydraulic data when the at least some of the received data are valid.

62. The system of claim **61**, wherein the well operation comprises a drilling operation.

63. The system of claim **62**, wherein at least one of the plurality of states comprises a drilling state.

64. The system of claim **63**, wherein the drilling state comprises rotary drilling.

65. The system of claim **63**, wherein the drilling state comprises sliding.

66. The system of claim **62**, wherein the at least one of the plurality of states comprises a testing state.

67. The system of claim **66**, wherein the testing state comprises a flow check on bottom.

68. The system of claim **66**, wherein the testing state comprises a flow check off bottom.

69. The system of claim **66**, wherein the testing state comprises a parameter check.

70. The system of claim **62**, wherein at least one of the plurality of states comprises a conditioning state.

71. The system of claim **70**, wherein the conditioning state comprises bottom hole conditioning.

72. The system of claim **70**, wherein the conditioning state comprises circulating off bottom.

73. The system of claim **70**, wherein at least one of the plurality of states comprises a tripping state.

74. The system of claim **73**, wherein the tripping state comprises tripping in hole.

75. The system of claim **73**, wherein the tripping state comprises reaming while tripping in hole.

76. The system of claim **73**, wherein the tripping state comprises working pipe while tripping in hole.

77. The system of claim **73**, wherein the tripping state comprises washing while tripping in hole.

78. The system of claim **73**, wherein the tripping state comprises back reaming while tripping out of hole.

79. The system of claim **73**, wherein the tripping state comprises working pipe while tripping out of hole.

80. The system of claim **73**, wherein the tripping state comprises washing while tripping out of hole.

81. The system of claim **62**, wherein the plurality of states comprises at least a drilling state, a testing state, and a tripping state.

82. The system of claim **62**, the logic further operable to:

determine whether the hole is being made based on the mechanical data; and

determine the state of the drilling operation based on whether the rig is making hole.

83. The system of claim **62**, the logic further operable to:

determine whether a drilling bit is on bottom based on the mechanical data; and

determine the state of the drilling operation based on whether the drilling bit is on bottom.

84. The system of claim **62**, the logic further operable to:

determine whether a drilling fluid is circulating based on the hydraulic data; and

determine the state of the drilling operation based on whether the drilling fluid is circulating.

85. The system of claim **62**, the logic further operable to:

determine whether a bit position is constant based on the mechanical data; and

determine the state of the drilling operation based on whether the bit position is constant.

86. The system of claim **62**, the logic further operable to indicate the state of the drilling operation.

87. The system of claim **62**, the logic further operable to recognize a drilling event based on the state of the drilling operation and data reported for the drilling operation.

88. The system of claim **62**, wherein at least one of the plurality of states comprises an in slips state.

89. The system claim **62**, wherein at least one of the plurality of states comprises a slip and cut line state.

90. The system of claim **61**, the logic further operable to use the state of the well operation to evaluate parameters and provide control for the operation.

91. An automated method for determining a state of a drilling operation comprising:

receiving mechanical and hydraulic data reported for a drilling operation;

based on the mechanical and hydraulic data, determining a state of the drilling operation; wherein the state of the drilling operation is determined to be:

drilling if:

a hole is being made; or

a hole is not being made, a drill bit associated with the drilling operation is on bottom and drilling fluid associated with the drill bit is circulating;

testing/conditioning if:

a hole is not being made, the drill bit is on bottom and the drilling fluid is not circulating; or

a hole is not being made, the drill bit is off bottom and the drill bit has a constant position; and

tripping/reaming if:

a hole is not being made, the drill bit is off bottom and the position of the drill bit is not constant.

92. The method of claim, **91**, wherein the state of the drilling operation is determined to be in slips if a hole is not being made, the drill bit is off bottom, the drill bit has a constant bit position and a hook load associated with the drilling operation is substantially equal to a block weight associated with the drilling operation.

93. The method of claim **91**, wherein the state of the drilling operation is determined to be slip and cut line if a hole is not being made, the drill bit is off bottom, the drill bit has a constant bit position and a hook load associated with the drilling operation is less than a block weight associated with the drilling operation.

94. An automated method for determining the state of a well operation, comprising:

storing a plurality of states comprising at least a productive and a non-productive state for the well operation;

receiving mechanical and hydraulic data reported for the well operation; and

determining that at least some of the data is valid by comparing the data to at least one limit, the at least one limit indicative of a threshold at which the at least some of the data do not accurately represent the mechanical or hydraulic condition purportedly represented by the at least some of the data; and

when the at least some of the data are valid, based on the mechanical and hydraulic data, automatically selecting one of the plurality of states as the state of the well operation.

95. The method of claim **94**, wherein the well operation comprises a drilling operation.

96. The method of claim **95**, wherein the productive state comprises a drilling state.

97. The method of claim **96**, wherein the drilling state comprises rotary drilling.

98. The method of claim **96**, wherein the drilling state comprises sliding.

99. The method of claim **95**, wherein the non-productive state comprises a planned state.

100. The method of claim **99**, wherein the planned state comprises at least one of a connection state, a maintenance state and a tripping state.

101. The method of claim **95**, wherein the non-productive state comprises an unplanned state.

102. The method of claim **101**, wherein the unplanned state comprises at least one of a conditioning state and a testing state.

103. The method of claim **94**, wherein the state is selected without direct input from an operator.

104. The method of claim **94**, wherein the state is selected without input from an operator.

105. An automated system for determining the state of a well operation, comprising:

logic encoded in media; and

the logic operable to receive mechanical and hydraulic data reported for the well operation, determine that at least some of the received data is valid by comparing the data to at least one limit, the at least one limit indicative of a threshold at which at least some of the

data do not accurately represent the condition purportedly represented by the at least some of the received data, and to automatically select one of a productive state and a non-productive state as a state of the well operation based on the mechanical and hydraulic data when the at least some of the received data are valid.

106. The method of claim **105**, wherein the well operation comprises a drilling operation.

107. The method of claim **106**, wherein the productive state comprises a drilling state.

108. The method of claim **107**, wherein the drilling state comprises rotary drilling.

109. The method of claim **107**, wherein the drilling state comprises sliding.

110. The method of claim **106**, wherein the non-productive state comprises a planned state.

111. The method of claim **110**, wherein the planned state comprises at least one of a connection state, a maintenance state and a tripping state.

112. The method of claim **106**, wherein the non-productive state comprises an unplanned state.

113. The method of claim **112**, wherein the unplanned state comprises at least one of a conditioning state and a testing state.

114. The method of claim **105**, wherein the state is selected without direct input from an operator.

115. The method of claim **105**, wherein the state is selected without input from an operator.

* * * * *

CERTIFICATE OF SERVICE

I hereby certify that, on this 30th day of November, 2015, I filed the foregoing Principal Brief for Plaintiff-Appellant TDE Petroleum Data Solutions, Inc. with the Clerk of the United States Court of Appeals for the Federal Circuit via the CM/ECF system, which will send notice of such filing to all registered CM/ECF users.

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CERTIFICATE OF COMPLIANCE

Pursuant to Fed. R. App. P. 32(a)(7)(C), the undersigned hereby certifies that this brief complies with the type-volume limitation of Fed. R. App. P. 32(a)(7)(B) and Federal Circuit Rule 32(b).

1. Exclusive of the exempted portions of the brief, as provided in Fed. R. App. P. 32(a)(7)(B), the brief contains 12,452 words.

2. The brief has been prepared in proportionally spaced typeface using Microsoft Word 2010 in 14 point Times New Roman font. As permitted by Fed. R. App. P. 32(a)(7)(C), the undersigned has relied upon the word count feature of this word processing system in preparing this certificate.

/s/Malcolm E. Whittaker
Malcolm E. Whittaker
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